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CONTENTS.

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NOTTINGHAM MEETING, AUGUST, 1866.

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The following is an epitome of the Report:—

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"Taking the four previous quinquennial periods, it is found that the first, from 1845 to 1849 inclusive, commenced with a sum assured for--

Year 1845 of £23,349, and ended the period with a total sum assured of					£272,796
The Second	1850—54				
Do.	1850	... 95,650...	do.	do.	733,408
The Third,	1855—60				
Do.	1855	...206,514...	do.	do.	1,655,678
The Fourth,	1860—64				
Do.	1860	...449,242...	do.	do.	3,439,215

And now the first year of the fifth like period—viz., 1865—the Company has granted assurances for £886,663, nearly twice the amount at the commencement of the last quinquennial period.

"If, therefore, the result of the total five years, ending in the year 1869, were to have a corresponding increase with the previous periods of five years each, the amount of business that would be effected in the quinquennial period now running would be more than has ever been on record in any Insurance establishment in this country.

"The Directors have likewise to report that the Life funds have increased by the sum of £103,146, the accumulated funds of this department now amounting to £740,458. As an addition of, at least, £100,000 per annum to these accumulations during the next ten years may now be fairly anticipated, it is within reasonable expectation that during this period the Life funds will approach nearly to £2,000,000 sterling.

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This Report was unanimously adopted.

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SATURDAY, SEPTEMBER 8, 1866.

CURRENT LITERATURE.

THE MILLENNIUM.

The End of All Things; or, The Coming and Kingdom of Christ. By the Author of "God is Love," &c. (Darton & Co.)

BY "Millenarian" the author understands those who believe in the personal reign of Christ upon earth, with his saints, for the period of a thousand years; and he feels that obligations of the most solemn kind are imposed upon him to do everything he can to expose the errors of such a system. The doctrine itself as just defined is, he assures us, making amazing progress, and it must be, indeed, if it is really true that more than half of the Evangelical clergy of the Church of England are at this moment Millenarians. Their belief appears to take a very practical, and we must say, a thoroughly logical turn. "I could mention," says our author, "some Christians who were, for many years, among the most liberal contributors to all the leading societies established for the extension of Christianity, but who, having become Millenarians, have almost entirely withdrawn their subscriptions from such societies, although their wealth has in the interim very greatly increased." This is a stroke of worldly prudence quite worthy of Dr. Cumming.

Millenarianism had its origin in certain traditions promulgated by Papias, a pious and well-meaning, but weak-minded man. It was said by Irenæus, and has often been repeated since, that Papias was one of the hearers of the Apostle John. But this was certainly not the case. He endeavoured to find out what John had said from any one who had conversed with the elders who had heard him. This is evidence at third or fourth hand, and is worth nothing. Papias appears to have been made of much more importance in recent times than he was in those when it was much more easy to judge of the real value of his opinions; and whatever inclination some few of the Fathers may have had for interpreting the allegory of Christ's reign upon earth into the prophecy of a literal fact, the idea was dissipated by the vigorous blows of Origen, and in the words of Gibbon, "at length rejected as the absurd invention of heresy and fanaticism." Millenarianism again revived in a singular form towards the year 1000 A.D., as no doubt it will do again towards the end of the next century. Many charters dated about that period begin "As the end of the world is now approaching," and many disposed of their property to monasteries, which took care not to make restitution when the critical moment had passed away. At the beginning of the present century Millenarianism was scarcely known. It was Edward Irving who, between 1827 and 1830, brought the Millenarian question into a prominence it never enjoyed before. Yet, singularly enough, his action was founded upon a literary fraud. He stumbled one day upon a Spanish book, entitled, "The Coming of the Messiah in Glory and Majesty." This was written by an author who professed to have been a Jewish convert to Christianity, and who gave the name of Juan Josaphat Ben-Ezra on the title-page. He was, however, a Spanish priest, of the Order of Ignatius Loyola, and his real name was Lacunza. Mr. Irving admired the book so much, that he translated it into English, and his name insured it a wide circulation. Besides this, he established a quarterly journal, called the *Morning Watch*, expressly devoted to advocating Millenarian views. But the general extravagance of his views seem to have impeded rather than promoted the reception of Millenarian views in sober minds, and even his immediate disciples must have doubted his judgment, if this account of his dying hours is correct:

When his physicians and friends, seeing him in the last stage of consumption, prepared him, in the spirit of affectionate faithfulness, for the solemn event which was at hand, he would not believe that he was dying, or ever would die, but that he would be changed in the twinkling of an eye, and, in a transformed body, made unspeakably glorious, be caught up to heaven. I have received this statement from one who saw him when on his dying bed.

Irvingism, however, is with many people another word for religious insanity. But a more energetic Propaganda of Millenarian notions has for some time been started. This is the "Prophecy Investigation Society." It consists of fifty members, all clergymen of the Church of England, with the exception of eight or nine laymen; and includes, or did include, the Bishops of Cashel and Ripon, and other persons of more or less eminence in the Church. The society has published a series of volumes on prophetic subjects, adding largely to apocalyptic literature. This is scarcely necessary, when we find that already, "nearly twelve hundred volumes have been written with a view to expound the whole or parts of the Book of Revelation, and that no two writers out of this large number agree together on all points." Then we have the *Quarterly Journal of Prophecy*, which has been established about fourteen years, and is said to have a very large circulation. It is conducted by Dr. Bonar, of Kelso, a minister of the Free Presbyterian Church of Scotland, though the majority of its contributors are clergymen of the Church of England. Then there is a montly Millenarian periodical, called the *Rainbow*, a sixpenny publication; and in the pages of the *Christian Observer*, the monthly organ of the Evangelical party in the Church of England, our author has detected very plain Millenarian tendencies. The weekly publications which are advocates of these views seem to be almost entirely supported by the various sections of Plymouth Brethren, Bible Christians, and other small bodies holding essentially the same opinions. One exception we must record, that of the *Revivalist*, a periodical which was established a few years ago, with the view of promoting revivals in personal religion, and vindicating the revivals in Ireland and other places, in 1859-60, from the attacks made on their genuineness and permanency. The occasion for doing this having somewhat passed away, it has now devoted itself to predicting the Millennium. It might have been thought that Millenarianism would have been specially productive of psalms and hymns and spiritual songs; but its efforts form no exception to the general rule as to the inferiority of religious poetry. Fifty-six hymns have been collected by an able expositor of these views, which are entitled "Songs of Hope," and together with his own are the most favourable specimens of these effusions.

The principle for which Millenarians contend, is a literal interpretation of Scripture,—literal interpretation is, indeed, the basis on which their theory entirely reposes. But if certain portions of Scripture, which seem to favour Millenarian views, are to be interpreted in a literal sense, the same rule ought to be applied to other passages of Scripture as well. But their chief writers are not very willing to allow this. "Whatever portions of the Word of God seem to sanction their Millenarian notions, however manifestly figurative may be their meaning to others, they dogmatically affirm to admit only of a literal interpretation; whereas, on the other hand, if particular passages, were they to be taken literally, should be at variance with their views, these they maintain ought to be received in a figurative sense." This is very absurd; but let us ask, by the way, if Millenarians are the only people who want to interpret Scripture after this fashion. They can, however, boast of at least one honourable exception. Mr. Molyneux, in "The Future of Israel," lays down the principle of an *invariable* literal interpretation of Scripture:

"It is," he says, "my firm conviction, that as all Scripture is intended for all men, so the literal principle of interpretation, which is the ONLY principle possible for all men, is the principle intended for the interpretation of ALL Scripture. And that it is the ONLY principle which, fairly and wisely applied, can unlock the treasures of God's Word, and unfold to the eye of faith an intelligible, consistent view of those 'good things to come,' 'which God has prepared for them that love him.'"

But our author applies a very severe test to Mr. Molyneux immediately:—

There is one passage to be met with repeatedly in substance in the Mosaic writings, which I ought not to overlook. It is one which is so obviously incompatible with the literal interpretation principle, that I can hardly believe even Mr. Molyneux himself would stand up for the application of that principle to it. I allude to the promise made by God to the Israelites, that they would find the Canaan into which he had engaged to bring them flowing with milk and honey. If they received this promise in the Millenarian or literal sense, they must have been grievously disappointed when they reached the shores and took possession of the land of Canaan, for they found no rivers of milk nor lakes of honey. The expression was only meant to convey to their minds the assurance that they would find it to be a good and pleasant land, in which they would have abundance of the best of food, and that it would prove in other respects to be a land of great enjoyment. The same observation is equally applicable to that other promise made by God to Abraham, that his descendants should inherit the land of Canaan for ever. It is a great historical fact, and a fact no less proved by the existing state of things, that the Promised Land has ceased, for more than two thousand years, to be inherited by the children of Abraham. The same remark may be made in relation to the promise made by God to Abraham, that his seed should be as numerous as the sand on the sea-shore. That could not be literally true: the seed of Abraham, however numerous they may hereafter prove to be, will not exceed the powers of arithmetic to compute; but the number of particles of sand on the sea-shore far exceed all the capabilities of arithmetic to calculate. They are innumerable. The expression, therefore, does not admit of a literal construction.

We have not got Mr. Molyneux's answer to this home-thrust. Perhaps he would do with some parts of the Mosaic writings as the Duke of Manchester did with Ezekiel:—

The late Duke of Manchester published a large and elaborate volume on the Book of Daniel. He was a decided Millenarian, and very partial to the study of prophetic subjects. Yet he felt that there was so much of the incomprehensibly allegorical element in Ezekiel, that he went to the extreme of not only refusing to recognize as authoritative anything in that book which might seem to sanction the Millennium theory, but of refusing to recognize it at all as one of the canonical books of Scripture. His friends were deeply grieved at this, and earnestly reasoned and remonstrated with him on the subject, but they failed to modify, much less to change, his views on the point.

The elaborate refutation of the literalists is, after this, scarcely necessary. Still the collection by a man of sincere piety of so many passages which refute their theory is not altogether without its value. But the most curious doctrine of which he gives an account is that of "The Secret Coming of Christ:" "Its meaning is, that before Christ comes to the earth, attended by all his glorified saints, to reign personally on it during the Millennial Period of a thousand years, all the saints of God who are alive will be *secretly* caught up by him to meet and remain in the air. Contemporaneously with this translation, the righteous dead shall be raised from their graves, and also ascend to be with Christ in the air." The world below would go on much the same as before, quite unconscious of the "solemn mirth" which was enacting in aerial regions, beyond, we suppose, the reach of any balloon, and in no way interfering with, or being interfered with, by the laws of gravitation and of matter. This extraordinary idea seems to have been due to Edward Irving alone. So convincing were the arguments he brought in its favour, that some of his people could think of nothing else:—

They expressed as firm a faith in the assumed fact that they would not experience bodily

death, but be caught up alive to meet the Lord in the air, as they did in any other doctrine in the Bible. But the fact of their having ultimately died and been buried, like the rest of mankind, furnished a proof, not to be mistaken, to their surviving friends of the delusion under which they laboured.

The Song of Solomon has always been a favourite stand-by for those who love allegorical interpretation, but it is claimed by the advocates of the "Secret Coming" as specially for them; and "one of the most eminent of the rapture class of writers finds therein the doctrine of the rapture of the Church, and wonders that anyone can be so blinded in his mind as not to see it 'plainly set forth' in that book!"

We shall be very glad to see the companion volume to this, which our author announces, though it will be scarcely necessary to prove "that there never probably has been a question in theology into which a greater amount of the purely fanciful element has been imported, than will be found in many of the various hypotheses advanced by Millenarians."

STONEWALL JACKSON.

Life of Lieut.-General Thomas J. Jackson (Stonewall Jackson). By Professor K. L. Dabney, D.D., of Richmond, Virginia. Vol. II. (Nisbet & Co.)

WHEN the first volume of this book appeared, about two years ago, though the issue of the great American struggle was no longer doubtful, it was still lawful for a Confederate writer to express a contrary hope whilst narrating the life of Stonewall Jackson. But Dr. Dabney is compelled to acknowledge in his preface to this, the concluding volume, that "the cause for which General Jackson fought and died has been overthrown." He tells us, indeed, that the whole work was written before the termination of the contest; but we cannot help thinking had that contest terminated differently, the tone of dejection which is natural enough as matters stand, would have been exchanged for something very different also.

There is one truth which is brought out more strongly in this military biography than in any other that was ever written—namely, that "Providence is on the side of the strongest battalions." The earnest and continuous prayers of Jackson were, so far as mortals can see, "whistled down the wind" no less contemptuously than the half of those of Homer's heroes generally was by the capricious deity to whom they happened to be addressed. The success of Havelock has been attributed to his piety. What shall we say of the useless bravery and undoubted sincerity of Jackson? Not that we ought to allow ourselves to fall into the error of supposing for a moment that no earnest prayers were poured forth on the side of the Federals. It is true now as it always has been in every struggle—

> Two hosts combine to offer sacrifice;

and nothing but the event can determine which incense has been most acceptable. The constant occasions on which General Jackson was found in prayer, and which are rather paraded before us by the author, make a disagreeable impression upon our minds. But the history of the man would not, perhaps, be complete without them. There is no such excuse for passages like the following:—

> Thus opened the seven days' tragedy before Richmond. The demeanour of its citizens during the evening of June 26th gave an example of their courage, and their faith in their leaders and their cause. For many weeks, the Christians of the city had given themselves to prayer; and they drew from heaven a sublime composure. The spectator passing through the streets saw the people calmly engaged in their usual avocations, or else wending their way to the churches, while the thunders of the cannon shook the city. As the calm summer evening descended, the family groups were seen sitting upon their doorsteps, where mothers told the children at their knees how Lee and his heroes were now driving away the invaders. The young people promenaded the heights north of the town, and watched the distant shells bursting against the sky. At one church, a solemn cavalcade stood waiting; and if the observer had entered, saying to himself, "This funeral reminds me that Death claims all seasons for his own, and refuses to postpone his dread rites for any inferior horrors," he would have found a bridal before the altar. The heart of old Rome was not more assured and stedfast, when she sold at full price in her *Forum* the fields on which the victorious Carthaginian was encamped.

Nor is it necessary to apologize for Jackson's resolution to fight upon a Sunday:—

> It was the Sabbath-day; and if there was one principle of General Jackson's religion which was more stringent than the others, it was his reverence for its sanctity. He had yielded to the demands of military necessity, so far as to march on the sacred morning, that he might not lose the advantages which opportunity seemed to place within his reach, but now a more inexorable necessity was upon him.

It is a curious fact, but one well known to all students of military exploits, that most of the great battles of modern times have been fought upon Sundays, and the reiterated assertions of our author that the General had a "quiet Sabbath," that "the quiet Sabbath was spent in religious worship," and complaints of the "*diabolical* explosive rifle-balls" of the Federals, read very much like expressions of querulous wonder that special miracles, like those of the Old Testament, were not exhibited to sustain the sinking cause of slavery. Indeed, the Confederates as a body seem to have looked upon Lincoln with much the same astonishment the Hebrews did upon Pharaoh. Thus, in January, 1863, we are told, "General Jackson, hoping, in common with many of his fellow-citizens, that the victories which God had vouchsafed to the Confederate arms in the year 1862 would convince the Federal people of the wickedness and unreasonable nature of their war, indulged some expectation that peace was not far off." Surely infatuation was never carried so far before. It cannot exalt our opinion of General Jackson's abilities or judgment when we find him so systematically underrating both the power and the moral resolution of his antagonists. Take again this letter to Colonel Preston, in which we find it difficult which most to be astonished at, the want of true political foresight, or the confidence that *his* special supplications must necessarily be answered in his own sense:—

> "I greatly desire to see peace—*blessed peace*. And I am persuaded that if God's people throughout our Confederacy will earnestly and perseveringly unite in imploring His interposition for peace, we may expect it. Let our Government acknowledge the God of the Bible as its God, and we may expect soon to be a happy and independent people. It appears to me that extremes are to be avoided, and it also appears to me that the old United States occupied an extreme position in the means it took to prevent the union of Church and State. We call ourselves a Christian people, and it seems to me that our Government may be of the same character, without connecting itself with an established church. It does appear to me that as our President, our Congress, and our people have thanked God for victories, and prayed to Him for additional ones, and he has answered such prayers, and gives us a Government, it is gross ingratitude not to acknowledge Him in the gift. Let the framework of our Government show that we are not ungrateful to Him."

Here again is a strangely intolerant sentence:—

> It was also a high evidence of the general soundness of religious opinion in the Confederate States, that there was not a single regiment in the army which showed a disposition to introduce a minister who did not belong to an evangelical and orthodox communion as their chaplain except one or two priests of the Romish Church. On the other hand, the office in the Federal army was as frequently filled by Universalists and other erratic heretics, or by laymen who never preached, as by regular ministers of the Gospel.

We are irresistibly reminded of that scene in "Waverley" where he finds the Baron of Bradwardine reading prayers to his own regiment on the eve of a battle; and are inclined to think there would be something rather more appropriate in prayer from the lips of a layman on such an occasion than Dr. Dabney appears capable of conceiving. He is, however, quite right in bringing pro minently before his readers the religious element in Jackson's character. The main lesson to be drawn we have already indicated. It will be one more proof additional to those which are accumulating every day to the effect that success in every undertaking depends upon its own intrinsic merits, and not in the personal character of those who may be drawn by circumstances into supporting by every sort of endeavour a hopeless and unworthy cause. Still, praying generals are so much rarer than swearing generals, that we are thankful for an animated picture of a successful one at Chancellorsville:—

> In this fashion General Jackson urged forward the attack until after nightfall. After the dispositions for the first attack were made, the only order given by him had been his favourite battle-cry, "Press forward." This was his message to every general, and his answer to every inquiry. As he uttered it, he leaned forward upon his horse, and waved his hand as though endeavouring by its single strength to urge forward his whole line. Never before had his pre-occupation of mind and his insensibllity to danger been so great. At every cheer from the front, which announced some new success, the smile of triumph flashed over his face, followed and banished immediately by the reverential gratitude with which he raised his face and his right hand to the heavens in prayer and thanksgiving. It was evident that he regarded this as his greatest victory, and never before was he seen so frequently engaged in worship on the field.

That evening was his last upon the field of battle. He had advanced a hundred yards beyond his own line, and when the defeated Federals again attempted to regain a barricade—

> General Jackson was now aware of their proximity, and perceived that there was no picket or skirmisher between him and his enemies. He therefore turned to ride hurriedly back to his own troops; and, to avoid the fire, which was thus far limited to the south side of the road, he turned into the woods upon the north side. It so happened that General Hill, with his escort, had been directed by the same motive almost to the same spot. As the party approached within twenty paces of the Confederate troops, these, evidently mistaking them for cavalry, stooped, and delivered a deadly fire. So sudden and stunning was this volley, and so near at hand, that every horse which was not shot down recoiled from it in panic, and turned to rush back, bearing their riders toward the approaching enemy. Several fell dead upon the spot, among them the amiable and courageous Boswell; and more were wounded. Among the latter was General Jackson.

It was a long time, many days, before he would believe his wound was mortal. The fullest details of that period are furnished by Dr. Dabney, and it is much the most pleasing portion of his work. The effect his death had upon the Confederates shows more clearly than ever the mistake of confounding the piety of a general with the goodness or the success of his cause. As long as Jackson lived, his praying might possibly create a more than ordinary enthusiasm amongst a select band. It was certain that his death would produce a dismay akin to the disappearance of a Palladium, or a talismanic standard. The εἷς οἰωνος ἄριστος which applies to every individual was concentrated in his safety. The effect of his death is well told, and it was a blow from which his fellow-soldiers never recovered:—

> Men said they had never admitted among their fears of possible calamity the apprehension that Jackson could fall in battle; for he had passed unscathed through so many perils, that he seemed to wear a charmed life. He was to his fellow-citizens the man of destiny, the anointed of God to bring in deliverance for his oppressed Church and country. They had seen

his form leading the van of victory, with such trust as the ancient Hebrews reposed in their kings and judges, when they went forth to turn to flight the armies of the aliens, anointed with holy oil, and guided to sure triumph by the oracles of Urim and Thummim and inspired seers. Even those who did not pray themselves, believed with a perfect assurance that his prayers found certain access to the heavens, and that the cause for which he interceded was secure under the shield of Omnipotence. The people of God, with a more intelligent and scriptural trust, gloried in his sanctity and Christian zeal, as a signal proof that the cause of their country was the cause of righteousness, in his pious example as a precious influence for good upon their sons who followed his banners, and in the homage done to Christ and His Gospel by his devotion. His soldiers trusted in his prestige with a perfect faith; for they had seen Fortune perch so regularly upon his flag, that the fickleness of her nature seemed to be changed for him into constancy. Jackson's corps, when fighting under his eye, always assailed the enemy with the certain expectation that victory and nothing but victory was to be the issue. His Commander-in-Chief, who best knew the value of his sleepless vigilance, his industry, his wisdom in council, and his vigour in action, appreciated his loss most fully of all. Men were everywhere speculating with solemn anxiety upon the meaning of his death.

DEMOCRACY.

On Democracy. By J. Arthur Partridge, Author of "The Making of the American Nation," &c. (Trübner & Co.)

A NEW YORK paper lately said, "This is the beginning of an Americanizing progress in England. The new democratic ideas are gradually to find an embodiment. The separation of Church and State, a complete secularization of politics, a removal of the Irish Church, the destruction of entail, and the greater freedom given to the transfer of land, the duty of a popular system of education apart from all associations with creed or Church." This boast, says Mr. Partridge, is widely feared in this country; and though he hesitates to endorse it in its entirety, it is only because his object is to bring out in a less hostile way the necessity of educating "the royal infant, the People," so as to make the future Sovereign as speedily as possible capable of entering upon his Imperial functions, and settling these questions in his own sense. By the "People" he makes us know very early in the day that he means the whole manhood of a nation, except paupers, lunatics, and criminals. Democracy again becomes possible "when the whole national manhood can organize itself on a basis of equality, and the two-fold question is whether Government can *so* be organized, and how?" Now Government partakes of the knowledge and the ignorance, the advantages and defects, of the actual ruling class. It endeavours either to express or to suppress the national intellect and will; and the organization of democracy, that is, as we understand our author, of an ever larger portion of the manhood of a nation, is of necessity the problem of every advancing age or people, and the one deadly unpardonable sin of nations is the failing to revolt against bad government. Of this sin it must be admitted few nations are guilty at the present day. Democracy again is the only system which is not a transitional one; and the only question about introducing it is one of time and adjustment. In England the only thing to be done is to graduate Reform in order to forestall Revolution. Here this may be effected peacefully; but, says Mr. Partridge, not so on the Continent. This, however, was written before the late campaign in Germany, and our prospects of civil strife between sovereign and subject have been much diminished by their common triumph. Europe he thinks stops half way between development and association; England has secured only partial freedom, and our neighbours an equality tempered with despotism. Both in England and Europe the Revolution and the Reformation have been arrested. Nothing can be more severe than the description given of our two great parties:—

> The Tories think, and say, and stick to it, that for the people to be represented would be dangerous to Church, King, State, and Constitution. The Whigs know better, but do worse. They act as though they believed it, and talk as though they did not. Practically, the creed of the two is one, and it is this, to take office and place, turn and turn about, one in, the other out, one out, the other in,—a large party, keeping it all in the family. They consider the Constitution saved as long as the people are kept from restoring its balances, and from interpreting it by the ancient spirit and by present facts, and they admit as much talent as is necessary to make themselves respectable.

Throughout, the example of America is held up as the one great lesson, that democracy is the most successful and the only final mode of government. Here is a figure in Mr. Partridge's best style: "The Monitor came round the corner!—and already, whatever might be the fleet of the future, it was sufficiently clear what were the fleets of the past. And deeper and deeper to the heart of the world presses the conviction that democracy is coming round the corner! Government founded upon the Few can run no fair race, can fight no equal battle, with governments founded upon the All."

A great part of the book is taken up with a refutation of the great "heresy" of J. S. Mill as regards plural voting. This would lead directly to revolution. "We denounce Mr. Mill's plan as a plan for the eternal subordination of the masses. Unless it secure that, it must secure revolution or destroy the country."

> Society in England is prepared to wait, or to advance by degrees, until education shall, beyond all doubt, have qualified the All as citizens. There is no need for experimentalizing upon the English Constitution with a measure of such new and tremendous power as one for plural voting.
>
> Education will, undoubtedly, prepare the All for power quite as fast as they will demand it. Mr. Mill himself insists upon it that the citizens of the only democratic country are all, in some sense, both "patriots and cultivated." He also admits the connexion between "these qualities and democratic institutions."
>
> To establish a plurality of voting power would be to create a more scientific and dangerous instrument of despotism and obstruction than has hitherto been invented for the enemies of mankind.
>
> The heresy of Mill resolves itself into a *disbelief in equality*,—that it is not possible without producing tyranny,—in other words, that it is not possible. To meet this theory of danger, he would make equality impossible. He would make inequality an institution, and expect the All to accept their degradation. He would bind over the people in sureties to wage eternal electoral war, for he would urge on development, and promote association, and when these have brought forth their inevitable offspring—Equality—he would say to the people, "Now you are getting dangerous, come on to my patent graduated sliding-scale, and let us see how many parts of a man you are entitled to be considered."

This, our author well observes, is first to create the power and then deny its use. Nor is he less bold from his own point of view:—

> To a great extent *poverty is itself a qualification.* It is more a qualification than a disqualification. If the question be "the right men in the right places,—merit, and not influence," the masses would vote for merit, the families would vote for "influence." In other words, each would vote for its own interest. With regard to war, the masses would incline against it, it means taxation; the few for it, it means employment, and also lavish expenditure, and a continuation of class monopolies of all sorts. On the other hand, the national honour is safe with the people, who would vote, fight, and pay in a just cause. We have had more than a century of frequent fighting for Bourbons, Legitimists, and Popes, for Austria and Turkey, and against Nations, Republics, and Progress generally. We should have had another war now for slavery, and against another Republic and Nation, if the million had not kept the peace which the oligarchy attempted to break. Further, war draws the working man for the militia, and trenches on his necessities, to promote extravagance in naval, military, and civil services.

The extracts we have given are enough to show the character of this singular book. It is not so picturesque in its language as its companion, "The Making of the American Nation;" and it is somewhat wearisome from its iteration. It must claim the merit of a most outspoken pleading in favour of manhood suffrage, independent enough to confute the momentary leaders of what seems pure democracy to the Tories; though, in the opinion of an Americanized intellect, little better than another form of class rule, the depotism of a privileged Minority.

Trust. By the Author of "The Beginnings of Evil." (London: Masters. 1866.)—In noticing a former work by this author, we spoke in high terms of the aim and object he had in view, and the manner in which the story was conceived and presented. The romantic story now before us we have read with pleasure, and can confidently state that it is a great improvement on its predecessor. It is founded on incidents experienced by the author during a visit to Spa, in Belgium, and will, we are sure, be read with interest by all those to whom it is addressed. There is nothing sensational in the plot; all ends happily as it should; and a Christmas-box comes in the shape of a son and heir to the hero and heroine.

The Reign of Richard the Second. The Stanhope Prize Essay for 1866. By T. P. Taswell Langmead. (Oxford: Rivingtons. 1866.)—Prize Poems and Prize Essays are usually of inferior merit. The pamphlet before us, however, though not conspicuously an exception to the general rule, cannot be charged with being either badly conceived or badly written. The chief events of the reign are well marshalled under the three heads, Ecclesiastical and Social History, Constitutional History, and Character and Personal History of the King, and are narrated so clearly that no one who feels interest in the period can fail to derive from the essay a concise and intelligible account of the King and his reign, derived from the ordinary sources, and containing the ordinary views. The fault of the author,—and this is a fault of most writers on historical subjects,—is a tendency to attribute great results to particular causes that lie on the surface. His biographical skill, too, seems rather defective. He shows little insight into character. He has not been able to seize the salient points of the King's character. For instance, he has not explained how it was that a man who, at one time, was terrified into assenting to a measure by a threat from the Commons to send for the statute by which Edward II. had been deposed, became afterwards with a facility that is remarkable, so despotic that Parliament considered their function was to do his bidding; nor how a youth who was wholly subservient to the influence of others suddenly felt himself in a position to express his intention, in a full council, of managing his own affairs. During the last two years of Richard's reign his government was tyrannical. How was it, then, that he was unable to secure to himself friends who, in the hour of need, would be able to save him? The question is not answered here; nor is there any approximation to a satisfactory reply. We differ from the writer in his belief that Richard escaped from Pomfret simultaneously with the rising in his favour of the Earls of Huntingdon, Kent, and Salisbury in 1400. The hypothesis, first suggested by Mr. Tytler, is yet nothing more than hypothesis.

The Probate Court Guide: Containing Suggestions as to Proof of Wills, and other Matters of Daily Practice in the Court. By John Brett, Solicitor. Pp. 32, 2*s.* (W. J. Johnson.)—To the profession this little hand-book will be found very useful in all non-contentious business. The various affidavits required by the modern practice are set out at full length, and it is worthy of observation that the third affidavit, technically called the "Affidavit of Execution," is generally required when testators make use of printed forms of wills. Suggestions are made by which little expenses may be avoided, which are worth attending to when the property in question is very small; but perhaps the most valuable one of all is that daily inquiry should be made as to whether the papers have gone from the Examiner of Ingrossments to the Clerk of the Seat, as it very often happens that papers re-

main for a week or a fortnight without being advanced a single stage, "owing to some unattended-to requirement in the office of the Examiner of Ingrossments."

PUBLICATIONS OF THE WEEK.

BLACKMORE (Richard Doddridge). Cradock Nowell. A Tale of the New Forest. 3 Vols. Post 8vo, pp. 962. *Chapman and Hall.* 31s. 6d.

BRYAN (Ruth). Letters of. By the Editor of "Handfuls of Purpose." With a Preface by the Rev. A. Moody Stuart. 2nd Edition. Post 8vo, pp. lxxx.—358. *Nisbet.* 5s.

BURT (Robert). The Stormontfield Piscicultural Experiments. 1853—1866. (Odds and Ends, No. 14.) Fscp. 8vo, sd., pp. 32. *Edmonston.* 6d.

CAREY (J., LL.D.). Learning Better than House and Land, as Illustrated in the Eventful Histories of Harry Johnson and Dick Hobson. New Edition, revised and adapted by the Rev. Charles Webster, D.D. 18mo, pp. 140. *Darton and Co.* 1s.

CHRONICLES and Memorials of Great Britain and Ireland during the Middle Ages. Liber Monasterii Hyda, Edited by E. Edwards, Esq. Roy. 8vo. *Longmans.* 10s.

——— Matthew Paris's Chronicle. Edited by Sir F. Madden, K.H., F.R.S. Vols. 1 and 2. Roy. 8vo. *Longmans.* Each 10s.

——— Year Books of the Reign of Edward I., Years 20 and 21. Edited and Translated by Alfred J. Horwood. Roy. 8vo. *Longmans.* 10s.

CONTEMPORARY Review (The). Vol. 2. May—August, 1866. Roy. 8vo, pp. 600. *Strahan.* 10s. 6d.

FRANCATELLI (Charles Elmé). Royal Confectioner: English and Foreign. A Practical Treatise on the Art of Confectionery in all its Branches; comprising Ornamental Confectionery artistically developed, &c., &c. Also the Art of Ice-making and the Arrangement and general Economy of Fashionable Desserts. 2nd Edition, with numerous Illustrations. Post 8vo, pp. xxvii.—422. *Chapman and Hall.* 9s.

GARDINER (Ner). Poems, Sonnets, and Lyrics. Fscp. 8vo, pp. viii.—132. *Micklem* (Manchester). *Simpkin.* 2s. 6d.

GILBERT (William). Doctor Austin's Guests. 2 Vols. Post 8vo, pp. 625. *Strahan.* 21s.

GREY (Mrs.). Old Dower House. New Edition. Fscp. 8vo, bds. *Ward and Lock.* 2s.

HICK. The Village Blacksmith; or, Piety and Usefulness Exemplified in a Memoir of the Life of Samuel Hick. By James Everett. 14th Edition. 32nd Thousand. Post 8vo, pp. xvi.—206. *Reed.* 2s. 6d.

HOGG and Johnson. A Selection of the Eatable Funguses of Great Britain. Edited by Robert Hogg, LL.D., F.L.S., and George W. Johnson, F.R.H.S., and Illustrated by W. G. Smith, F.A.L.S. 24 Coloured Plates. 8vo. *Journal of Horticulture Office.* 7s. 6d.

HORACE Hazelwood, or Little Things. And other Tales. (The Children's Hour Series). Fscp. 8vo, pp. vii.—328. *Johnstone and Hunter.* 3s.

INGATE (Mrs. Sophia). Few Words to Young Mothers on the Care of their Children in Sickness and Health. 12mo, sd., pp. 23. *Cornish* (Birmingham); *Simpkin.* 1s.

JACKSON (Lieut.-General Thomas J.) (Stonewall Jackson), Life of. By Professor R. L. Dabney, D.D. Vol. 2. Post 8vo, pp. xvi.—527. *Nisbet.* 7s. 6d.

JAMES (M. Prosser, M.D.). Visit to Vichy, comprising a Sketch of its Mineral Springs and Thermal Establishment, with a Notice of the Medicinal Uses of the Vichy Waters, Salts, and Lozenges. 3rd Edition. 8vo, sd., pp. ii.—50. *Williams and Co.* 1s.

JOHNS (Rev. B. G.). First Book of Poetry. 10th Edition. (Darton's School Library). 18mo, cl. sd. *Darton.* 1s.

KELLEY (Henry). Sculling, Rowing, and Yachting. (Champion Handbooks.) Fscp. 8vo, bds. pp. 63. *Darton and Hodge.* 6d.

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MACLEAR (Rev. G. F., M.A.). Shilling Book of Old Testament History for National and Elementary Schools. 18mo, cl. sd., pp. 124. *Macmillan.* 1s.

MALLESON (Rev. E., M.A.). The Life of Faith. A Sermon Preached at St. James's Church, Baldersby, on Sunday, August 12, 1866, being the Sunday after the Funeral of the Rev. Dr. Neale. 8vo, sd., pp. 15. *Hayes.* 6d.

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MAXWELL (Hon. S. R.). Atonement the only efficient Exponent of God's Love to Man. 12mo. *Yapp.* 1s. 6d.

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ROE (Arthur S.). Long Look Ahead: or, the First Stroke and the Last. Unabridged Edition. (Run and Read Library). Fscp. 8vo, bds., pp. 311. *Ward and Lock.* 2s.

——— True to the Last; or, Alone on a Wide, Wide Sea. New Edition. (Run and Read Library.) Fscp. 8vo, bds., pp. 315. *Ward and Lock.* 2s.

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RUSSELL (John, Earl). Essay on the History of the English Government and Constitution. From the Reign of Henry VII. to the Present Time. New Edition. Post 8vo, pp. xii.—300. *Longmans.* 6s.

SEWELL (Mrs.). Rose of Cheriton. A Ballad. Fscp. 8vo, sd., pp. 91. *Jarrold.* 6d.; cl. sd., 1s.

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WALKER'S Pronouncing Dictionary of the English Language. Edited by P. Austin Nuttall, LL.D. Pearl Edition. Fscp. 8vo, bds. *Warne.* 1s.

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CORRESPONDENCE.

NEW LATIN PRIMER.

To the Editor of THE READER.

Sir,—I quite agree with the anonymous critics in the *Times*, and with the writer of the short notice you have taken of the New Latin Primer in your late numbers; the language used by its author is too difficult, not only for *all* pupils, but for *many* teachers. Neither does it help us that the author of that work in the *Times* of to-day says we shall hereafter be thankful for having a new nomenclature introduced into our schools; for that nomenclature, as far as I can see, is hardly English at all. It is already the tendency of many writers, and of newpaper writers above all, to use as many fine words as they can, having no care or thought, as it would seem, of our old Teutonic and Scandinavian words, though these are equally comprehensive, and much stronger than the words which answer to them taken from the Latin or Norman French.

Allow me, however, to point out to your critic that he has censured the author of the Latin Primer for what is in fact a proof of his elegant scholarship. Your critic is wrong in suggesting, "Sic quoque *m* post *g*," &c.; and "J sequitur *x z*," &c. The author of the Primer is correct in writing, "Nec mĭnŭs | *m* post | *g*," &c.; and "J sŭbĭt, | *x*, aut *z*," &c.

The fact is, *m* is equivalent to *ēm*, and *x* to *ēx*, so that there would be (if your critic's emendation were followed) a false quantity, which now there is not.—I am, Sir, yours faithfully,

J. A. GILES.

Alexandra College, Ealing, W, Sept. 3, 1866.

THE BELGIAN BONE CAVES.

To the Editor of THE READER.

Sir,—I see in to-day's *Reader* a note to the effect that Sir W. F. Guise and Mr. W. S. Symonds have contributed a paper to the Cotteswold Naturalists' Field Club, on the physical geology of the caverns on the River Lesse.

Taking, as I do, some interest in these caves, I cannot reprobate too strongly this disingenuous and underhand publication. All those who have visited the Belgian caves near Dinant know that M. Edouard Dupont is employed by the Belgian Government to make the scientific investigations into these caves. M. Dupont will, in time, publish his own report; and it is a breach of good faith for any person who may have visited Dinant, and inspected M. Dupont's collection, or who may have enjoyed that generous man's hospitality, to publish without the knowledge of the original discoverer a garbled and untrue version of the facts. The laws of hospitality should have led the dilettanti tourists, who vaguely and purposelessly wandered near the bank of the Lesse, to refrain from publication until M. Dupont should himself have laid all his facts before a scientific world. Sir William Guise, not being a scientific man, should certainly not have "rushed in" where M. Dupont "has feared to tread," and although the Rev. Mr. Symonds' capabilities to write children's books may be great, a little less scientific interloping, and a little more respect for his neighbour's property, would increase my respect for this amateur investigator. The assertion, if Mr. Symonds' has really made it, that the human jaw recently found was discovered at or even near Furfooz, is a statement which my sentiments of respect for the clergy, however "unattached," do not allow me to describe by its proper epithet. Perhaps Mr. Symonds can state the length of time he was at Dinant, and how much thereof was spent in the investigations on the banks of the Lesse?—I am, Sir, F.G.S.

September 1, 1866.

THE BESSEMER PROCESS IN ITALY.

IN spite of the difficulties attending the manufacture of iron, it is one of the metals first mentioned in history; Moses tells us that Tubal-cain was an instructor of every artificer in brass and iron, and that iron furnaces were used in ancient Egypt. Homer, in speaking of the funeral games given by Achilles in honour of Patroclus, informs us of the great value of iron in those days, a mass of it being given as a prize:—

> A mass of iron—an enormous round—
> Whose weight and size the circling Greeks admire,
> Rude from the furnace, and but shaped by fire.
>
> . . . . . .
>
> Who furthest hurls it takes it as his prize."

Diodorus Siculus relates that the inhabitants of the Island of Elba dug and cut iron-ore out of the ground, afterwards smelting it to obtain the metal. And now, even in this golden age, though centuries have passed since Hephæstus threw the materials out of which Achilles' shield was to be forged into a furnace urged by twenty pairs of bellows, iron still retains its place in the scale of utility, if not in that of value.

Italy, in the many advances she has lately made towards political freedom, has not been behind hand in introducing the latest improvements in her manufactures. Early in 1865, an English gentleman, Mr. Novello, in partnership with MM. Ponsard and Gigli, commenced the erection of an extensive establishment near the city of Piombino, for the manufacture of malleable iron by the Bessemer process; and on the 11th of last April, their works, called the "Magona d'Italia," and extending over 3,000 square yards, were inaugurated by Senator Torelli.

Before we describe the mechanical part of Mr. Bessemer's invention, it will be necessary to give some account of the chemical theory as to the changes which have to be effected in the crude cast-iron, called pig, in order to convert it into malleable or bar-iron. The pig obtained from the blast-furnace has always combined with it certain foreign matters, such as carbon, silicon, sulphur, phosphorus, &c., which more or less affect its natural properties of malleability and ductility. And although these foreign matters are essential to give the required fusibility to the iron ore for obtaining cast-iron from it, and also for the production of cast-iron articles, still it is absolutely necessary to get rid of them when an iron of greater tenacity and strength is required. The process of thus purifying cast-iron is termed refining. The following analysis, by comparing the percentage of foreign substances in pig-iron with the percentage of the same in the iron after it has been refined, will give some idea of the work to be performed:—

	Iron from furnace before refining.	Same Iron after having been refined.
Iron	95·26	98·33
Carbon	2·63	·87
Silicium	1·38	[illegible]
Aluminium	·73	·26
Sulphur	Traces	Traces
Phosphorus	Traces	Traces

Since the process of refining iron is effected by aid of combustion, it may not be superfluous to say a few words about combustion itself, a subject generally but little understood. In order to appreciate this matter, we must know that heat is merely the vibratory motion of the molecules of which the heated substance consists, and that the intensity of the heat is always in proportion to the greater or less violence of this molecular motion. The same may be said of light,—with this difference, however, that to produce the faintest impression upon the retina, the atoms will oscillate with a rapidity thousands of times greater than necessary to produce intense heat. Combustion is a case in which such molecular motion is induced by the collision of different atoms urged towards each other by chemical

affinity that heat and light are produced simultaneously. Thus it is to the clashing together of the oxygen of the air and constituents of our gas and candles that the light and heat of our flames are due ; from which it will be easily understood why increased combustion is produced when a strong current of air is brought to play upon matter already burning—as, for example, when we blow our fires, for we thereby bring a greater number of atoms of air in collision with the constituents of the coals or wood, their motion of translation being destroyed by their impact, assumes those motions called heat and light, or in other words, the motion of the air from the spout of the bellows, by striking the burning mass, is converted (not destroyed) into an undulatory movement which produces the phenomena of heat and light.

The chemical affinity, or chemism, as it has been lately styled, between oxygen and carbon, is such that at a white heat they cannot exist in the presence of each other without uniting. Should the carbon even be in combination with iron, so soon as this compound (carburet of iron) is heated to whiteness, and oxygen be brought into contact with it, although this also should be in union with another substance, such as nitrogen, the carbon and oxygen separate from their former companions, and violently rush together, creating, in the intensity of their affinity, an enormous heat. The rapidity of the combustion, and intensity of the consequent heat, will naturally depend on the extent of surface of carbon brought into contact with the oxygen. After the carbon has been thus all absorbed from the iron, and has passed away as carbonic acid gas, the oxygen, on being brought still in contact with the iron, now combines with it, forming an oxide of iron. The excessive heat generated by the combustion fuses this oxide directly it is formed, and, being a powerful solvent of those earthy bases which are associated with the iron, it washes and cleanses the metal from them. The sulphur and other volatile matters which cling so tenaciously to iron at ordinary temperatures are now driven away, passing off as fumes, the oxygen and sulphur combining to form sulphurous acid ; and thus nearly pure iron is obtained.

It must, however, be observed that pure metallic iron containing no carbon is a very soft metal, and useful only for purposes in which tenacity alone is required, and that consequently to obtain the necessary hardness about 7 per cent. of liquid cast-iron or *spiegeleisen* (a cast-iron containing about 5 per cent or more of manganese) must be added, in sufficient quantity to yield a metal with about 1½ per cent of carbon. The change to be effected, then, is the oxidation, and consequent separation, of a great portion of the impurities contained in the pig-iron. Mr. Bessemer, with a view to carry this theory into effect, causes a continuous current of atmospheric air, a compound of nitrogen and oxygen, to pass through a mass of molten cast-iron. No other combustibles are required than those contained in the pig itself ; the intense heat being evolved partly by the combustion of the carbon and partly by that of the iron, the fluid mass being kept in violent agitation by the nitrogen and carbonic oxide,* which pass through it. He invented many different apparatuses called "convertors," each more ingenious than the other, and at last was so successful, that this hitherto difficult operation has been rendered most easy. We will now endeavour to describe one of these convertors as it exists in the works of Messrs. Novello, Ponsard, and Gigli, the sole proprietors of the patent in Italy.

At the Magona d'Italia, in Piombino, the cast iron is manufactured from the Elba ore in an ordinary blast-furnace ; the liquid cast-iron is then run into a Bessemer convertor—*i.e.*, an iron cylindrical vessel, somewhat of the form of a cupola furnace, sufficiently large to refine 3,000 kilos. of cast-iron at a time. The inside of the convertor is lined with fire-bricks, and near the bottom are several vertical *tuyères*, pipes through which the air is forced by means of steam power. The air on rushing through the bath of cast-iron, separates the carbon and other heterogeneous substances from the iron. The time requisite for the conversion varies from ten to fifteen minutes, according to the purity of the cast-iron, and quantity of air driven through it. The convertor is moveable, so that it may be inclined to the right or left each time the crude iron is introduced or the refined metal extracted. At the commencement of the operation scoriæ are formed and partly projected from the throat of the converting vessel in a shower of fire ; the flames, at first of a violet red colour, become yellow, and at last beautifully white, the sparks, however, gradually diminish, forming towards the end of the process a luminous jet composed of a succession of brilliant specks. The progress of the refining is indicated by the appearance of the flames. Kirschhoff and Bunsen, some few years ago, in examining the spectra obtained by the combustion of different metals, discovered that each gave a series of dark lines peculiar to itself, and that consequently by analyzing any spectrum it is possible to detect what metals are entering into combustion. Professor Roscoe has lately applied this discovery to the Bessemer process, and now, by aid of a spectroscope, the exact moment to stop the refining blast can be determined. When the cast-iron is considered to be entirely converted, the blast of air is stopped, the apparatus tilted, and the molten liquid poured into a caldron moved by a hydraulic crane. So soon as the caldron is full, it is raised by the crane, which then rotates, carrying the caldron over a circle of moulds prepared to receive the refined iron. The metal is allowed to remain a few minutes in the moulds, when they are withdrawn, and the bars of malleable iron are afterwards passed under heavy steam hammers and rollers. The hydraulic power by which the convertors, the central crane, &c., are moved, is so managed that one man is able to distribute the pressure at will to any of the different machines. The moulds are of various sizes, some capable of containing upwards of 6,000 kilogrammes of metal. The forms of malleable iron or steel, on being withdrawn from the moulds, are heated at a furnace before being beaten by the large steam-hammer, the moveable block of which weighs five tons, and when in action can descend with a momentum of twenty-five tons ; there are also endless smaller steam hammers in the establishment. Between five and six tons of steel are daily turned out, and it is expected that within a few months, when the workmen become more expert, twice that quantity will be manufactured. The quality of the metal produced at these works is very superior, and well-fitted for machinery and agricultural implements. It solders very readily, its malleability is almost equal to that of copper, and whether heated or cold, it may be drawn out into wire, or made to assume any curve.

We cannot take leave of the Magona d'Italia, without expressing our wishes for the prosperity of a firm so important to the nation, and at the same time one in which the efforts of an Englishman, a Frenchman, and an Italian are combined, an incident truly typical of that union among nations which commerce alone seems capable of effecting.

* It often happens that the air, after forming carbonic acid with the fuel with which it first comes in contact, is then forced over other red-hot fuel, so as to reduce this carbonic acid (C O2) to carbonic oxide (C O), which escapes unburnt. (See Chemistry, A W. Williamson, page 73.)

SCIENCE.

BRITISH ASSOCIATION.

On the Results of Spectrum Analysis applied to the Heavenly Bodies. By William Huggins, F.R.S., F.R.A.S.*

An important invention or discovery seldom, if ever, remains sterile and alone. It gives birth to other discoveries. The telescope and the microscope have led to remarkable discoveries in Astronomy and in minute Anatomy and Physiology, which would not have been possible without those instruments. The observation that a magnetic body, free to move, arranges itself nearly north and south, has not only contributed immensely to the extension of commerce, and of geographical discovery, but also has founded the important science of terrestrial magnetism.

This evening I have to bring before you some additions to our knowledge in the department of Astronomy, which have followed from a comparatively recent discovery. The researches of Kirchhoff have placed in the hands of the astronomer a method of analysis which is specially suitable for the examination of the heavenly bodies. So unexpected and important are the results of the application of spectrum analysis to the objects in the heavens, that this method of observation may be said to have created a new and distinct branch of astronomical science.

Physical Astronomy, the imperishable and ever growing monument to the memory of Newton, may be described as the extension of terrestrial dynamics to the heavens. It seeks to explain the *movements* of the celestial bodies on the supposition of the universality of an attractive force similar to that which exists upon the earth.

The new branch of astronomical science which spectrum analysis may be said to have founded, has for its object to extend the laws of terrestrial physics to the other phenomena of the heavenly bodies, and it rests upon the now established fact, that matter of a nature common to that of the earth, and subject to laws similar to those which prevail upon the earth, exists throughout the stellar universe.

The peculiar importance of Kirchhoff's discovery to *astronomy* becomes obvious, if we consider the position in which we stand to the heavenly bodies. Gravitation and the laws of our being do not permit us to leave the earth, it is therefore by means of *light alone* that we can obtain any knowledge of the grand array of worlds which surround us in cosmical space. The star-lit heavens is the only chart of the universe we have, and in it each twinkling point is the sign of an immensely vast though distant region of activity.

Hitherto the light from the heavenly bodies, even when collected by the largest telescopes, has conveyed to us but very meagre information, and in some cases only of their form, their size, and their colour. The discovery of Kirchhoff enables us to interpret symbols and indications hidden within the light itself, which furnish trustworthy information of the chemical, and also to some extent of the physical condition of the excessively remote bodies from which the light has emanated.

We are indebted to Newton for the knowledge that the beautiful tints of the rainbow are the common and necessary ingredients of ordinary light. He found that when white light is made to pass through a prism of glass it is decomposed into the beautiful colours which are seen in the rainbow. These colours when in this way separated from each other form the *spectrum* of the light. Let this white plate represent the transverse section of a beam of white light travelling towards you. Let now a prism be interposed in its path. The beam of white light is not turned aside as a whole, but the coloured lights composing it are deflected differently, each in proportion to the rapidity of its vibrations. An obvious consequence will be, that on emerging from the prism the coloured lights which formed the white light will separate from each other, and in place of the white light which entered the prism we shall have *its spectrum*, that is, the *coloured lights which composed it, in a state of separation from each other.* Wollaston and Fraunhofer discovered that when the light of the sun is decomposed by a prism, the rainbow colours which form its spectrum are not continuous, but are interrupted by a large number of dark lines. These lines of darkness are the symbols which indicate the chemical constitution of the sun. It was not until recently, in the year 1859, that Kirchhoff taught us the true nature of these lines. He himself immediately applied his method of interpretation to the dark lines of the solar spectrum, and was rewarded by the discovery that several of the chemical elements which exist upon the earth are present in the solar atmosphere.

It is my intention to bring before you this evening the results of the extension of this method of analysis to the heavenly bodies other than the sun. These researches have been carried on in my Observatory during the last four years. In respect of a large part of these investigations, —viz., those of the moon, the planets, and fixed stars—I have had the great pleasure of working conjointly with the very distinguished chemist

* This Lecture was delivered in the Theatre, Nottingham, on Thursday evening, August 23rd.

and philosopher, Dr. Wm. A. Miller. Half-a-century ago Fraunhofer recognized several of the solar lines in the light of the Moon, Venus, and Mars, and also in the spectra of several stars. Recently Donati, Janssen, Secchi, Rutherford, and the Astronomer Royal have observed lines in the spectra of some stars. Before I describe the results of our observations, I will state, in a few words, the principles of spectrum analysis upon which our interpretation of the phenomena we have observed has been based, and also the method of observing which we have employed.

When light which has emanated from different sources is decomposed by a prism, the spectra which are obtained may differ in several important respects from each other. All the spectra which may present themselves can be conveniently arranged in three general groups. A *spectrum* illustrating each of these three orders is placed upon the diagram.

1. The special character which distinguishes spectra of the *first order* consists in that the continuity of the coloured band is unbroken either by dark or bright lines. By means of the electric lamp, Mr. Ladd will throw a spectrum of this order upon the screen. We learn from such a spectrum that the light has been emitted by an opaque body, and almost certainly by matter in the solid or liquid state. A spectrum of this order gives to us no knowledge of the chemical nature of the incandescent body from which light comes. In the present case, the light is emitted by the white-hot carbon points of the electric lamp. A spectrum, in all respects similar, would be formed by the light from incandescent iron, or lime, or magnesia.

2. Spectra of the *second order* are very different. These consist of coloured lines of light separated from each other. From such a spectrum we may learn much. It informs us that the luminous matter from which the light has come is in the *state of gas*. It is only when a luminous body is free from the molecular trammels of solidity and liquidity that it can exhibit its own peculiar power of radiating some coloured rays alone. Hence substances, *when in a state of gas*, may be distinguished from each other by their spectra. Each element, and every compound body that can become luminous in the gaseous state without suffering decomposition, is distinguished by a group of lines peculiar to itself. These green lines are produced by silver in a state of gas, and only by silver gas. It is obvious that if the groups of lines characterizing the different terrestrial substances be known, a comparison of these as standard spectra with the spectrum of light from an unknown source will show whether any of these terrestial substances exist in the source of the light.

3. The *third order* consists of the spectra of incandescent solid or liquid bodies, in which the continuity of the coloured light is broken by dark lines. These dark spaces are not produced by the source of the light. They tell us of vapours through which the light has passed on its way, and which have robbed the light, by absorption, of certain definite colours or rates of vibration ; such spectra are formed by the light of the sun and stars.

Kirchhoff has shown that if vapours of terrestrial substances come between the eye and an incandescent body, they cause groups of dark lines, and further, that the *group of dark lines* produced by each vapour is identical in the number of the lines and in their position in the spectrum with the *group of bright lines* of which its light consists when the vapour is luminous.

Mr. Ladd will throw upon the screen the spectrum of incandescent carbon points which contain sodium. Observe in addition to the continuous spectrum of the incandescent carbon a bright yellow band, which indicates the presence of sodium. Now a piece of metallic sodium will be introduced into the lamp. The sodium will be vaporized by the heat, and will fill the lamp with its vapour. This vapour absorbs, quenches the light that it emits when luminous. There will thus be produced a black line exactly in the place where the bright yellow line was seen.

It is evident that Kirchhoff by this discovery has furnished us with the means of interpreting the dark lines of the solar spectrum. For this purpose it is necessary to compare the bright lines in the spectra of the light of terrestrial substances, when *in the state of gas*, with the dark lines in the solar spectrum. When a group of bright lines coincides with a similar group of dark lines, then we know that the terrestrial substance producing the bright lines is present in the atmosphere of the sun. For it is this substance, and this substance alone, which, by its own peculiar power of absorption, can produce that particular group of dark lines. In this way Kirchhoff discovered the presence of several terrestrial elements in the solar atmosphere.

METHODS OF OBSERVATION.

I now pass to the special methods of observation by which, in our investigations, we have applied these principles of spectrum analysis to the light of the heavenly bodies. I may here state that several circumstances unite to make these observations very difficult and very irksome. In our climate, on few only even of those nights in which the stars shine brilliantly to the naked eye, is the air sufficiently steady for these extremely delicate observations. Further, the light of the stars is feeble. This difficulty has been met, in some measure, by the employment of a large telescope. The light of a star falling upon the surface of an object-glass of eight inches aperture is gathered up and concentrated at the focus into a minute and brilliant point of light.

Another inconvenience arises from the apparent movement of the stars, caused by the rotation of the earth, which carries the astronomer and his instruments with it. This movement was counteracted by a movement given by clockwork to the telescope in the opposite direction. In practice, however, it is not easy to retain the image of a star for any length of time exactly within the jaws of a slit only the 1-300th of an inch apart. By patient perseverance these difficulties have been overcome, and satisfactory results obtained. We considered that the trustworthiness of our results must rest chiefly upon *direct and simultaneous comparison* of terrestrial spectra with those of celestial objects. For this purpose, we contrived the apparatus which is represented in the diagram.

By this outer tube the instrument is adapted to the eye-end of the telescope, and is carried round with it by the clock motion. Within this outer tube a second tube slides carrying a cylindrical lens. This lens is for the purpose of elongating the round point-like image of the star into a short line of light, which is made to fall exactly within the jaws of a nearly-closed slit. Behind the slit, an achromatic lens (and at the distance of its own focal length) causes the pencils to emerge parallel. They then pass into two prisms of dense flint glass. The spectrum which results from the decomposition of the light by the prisms is viewed through a small achromatic telescope. This telescope is provided with a micrometer screw, by which the lines of the spectra may be measured.

The light of the terrestrial substances which are to be compared with the stellar spectra is admitted into the instrument in the following manner :—

Over one-half of the slit is fixed a small prism, which receives the light reflected into it by the moveable mirror placed above the tube. The mirror faces a clamp of ebonite, provided with forceps to contain fragments of the metals employed. These metals are rendered luminous in the state of gas by the intense heat of the sparks from a powerful induction coil. The light from the spark reflected into the instrument by means of the mirror and the little prism passes on to the prisms in company with that from the star. In the small telescope the two spectra are viewed in juxta-position, so that the coincidence and relative positions of the bright lines in the spectrum of the spark with dark lines in the spectrum of the star can be accurately determined.

MOON AND PLANETS.

I now pass to the results of our observations.

I refer in a few words only to the moon and planets. These objects, unlike the stars and nebulæ, are not original sources of light. Since they shine by reflecting the sun's light, their spectra resemble the solar spectrum, and the only indications in their spectra which may become sources of knowledge to us are confined to any modifications which the solar light may have suffered either in the atmospheres of the planets, or by reflexion at their surfaces.

Moon.—On the moon the results of our observations have been negative. The spectra of the various parts of the moon's surface, when examined under different conditions of illumination, showed no indication of an atmosphere about the moon. I also watched the spectrum of a star, as the dark edge of the moon advanced towards the star, and then occulted it. No signs of a lunar atmosphere presented themselves.

Jupiter.—In the spectrum of Jupiter lines are seen which indicate the existence of an absorptive atmosphere about this planet. In this diagram these lines are presented as they appeared when viewed simultaneously with the spectrum of the sky, which at the time of observation, reflected the light of the setting sun. One strong band, corresponds with some terrestrial atmospheric lines, and probably indicates the presence of vapours similar to those which are about the earth. Another band has no counterpart amongst the lines of absorption of our atmosphere, and tells us of some gas or vapour which does not exist in the earth's atmosphere.

Saturn.—The spectrum of Saturn is feeble, but lines similar to those which distinguish the spectrum of Jupiter were detected. These lines are less strongly marked in the ansae of the rings, and show that the absorptive power of the atmosphere about the rings is less than that of the atmosphere which surrounds the ball. A distinguished foreigner present at the meeting, Janssen, has quite recently found that several of the atmospheric lines in this part of the spectrum are produced by aqueous vapour. It appears to be very probable that aqueous vapour exists in the atmospheres of Jupiter and Saturn.

Mars.—On one occasion some remarkable groups of lines were seen in the more refrangible part of the spectrum of Mars. These may be connected with the source of the red colour which distinguishes this planet.

Venus.—Though the spectrum of Venus is brilliant, and the lines of Fraunhofer were well seen, no additional lines affording evidence of an atmosphere about Venus were detected. The absence of lines may be due to the circumstance that the light is probably reflected, not from the planetary surface, but from clouds at some elevation above it. The light which reaches us in this way by reflexion from clouds would not have been exposed to the absorbent action of the lower and denser strata of the planet's atmosphere.

THE FIXED STARS.

The fixed stars, though immensely more remote, and less conspicuous in brightness than the moon and planets, yet because they *are original sources of light*, furnish us with fuller indications of their nature.

To each succeeding age the stars have been a beauty and a mystery. Not only children, but the most thoughtful of men often repeat the sentiment expressed in the well-known lines :—

> "Twinkle, twinkle, pretty star,
> How I wonder what you are."

The telescope was appealed to in vain, for in the largest instruments the stars remain diskless, brilliant points merely.

The stars have indeed been represented as suns, each upholding a dependent family of planets. This opinion rested *upon a possible analogy alone*. It was not more than a speculation. We possessed no certain knowledge *from observation* of the true nature of those remote points of light. This long and earnestly-coveted information is at last furnished by spectrum analysis. We are now able to read in the light of each star some indications of its nature. Since I have not a magician's power to convert this theatre into an observatory, and so exhibit to you the spectra of the stars themselves, I have provided photographs of careful drawings. These photographs Mr. Ladd will exhibit upon the screen by means of the electric lamp. I will take first the spectra of two bright stars which we have examined with great care.

The upper one represents the spectrum of Aldebaran, and the other that of Betelgeux, the star marked α in the constellation of Orion.

The positions of all these dark lines, about 80 in each star, were determined by careful and repeated measures. These measured lines form but a small part of the numerous fine lines which may be seen in the spectra of these stars.

Beneath the spectrum of each star are represented the bright lines of the metals which have been compared with it. These terrestrial spectra appeared in the instrument as you now see them upon the screen, in *juxta-position* with the spectrum of the star. By such an arrangement, it is possible to determine with great accuracy whether or not any of these bright lines actually coincide with any of the dark ones. For example :—

This closely double line is characteristic of sodium. You see that it coincides, line for line, with a dark line similarly double in the star. The vapour of sodium is therefore present in the atmosphere of the star, and sodium forms one of the elements of the matter of this brilliant but remote star.

These three lines in the green are produced, so far as we know, by the luminous vapour of magnesium *alone*. These lines agree in position exactly, line for line, with three dark stellar lines. The conclusion, therefore, appears well founded that another of the constituents of this star is magnesium.

Again, there are two strong lines peculiar to the element *hydrogen*, one line has its place in the red part of the spectrum, the other at the blue limit of the green. Both of these correspond to dark lines of absorption in the spectrum

of the star. Hydrogen, therefore, is present in the star.

In a similar way, other elements, among them bismuth, antimony, telurium, and mercury, have been shown to exist in the star.

Now, in reference to all those elements, the evidence does not rest upon the coincidence of *one* line, which would be worth but little, but upon the coincidence of a group of two, three, or four lines, occurring in different parts of the spectrum. Other corresponding lines are probably also present, but the faintness of the star's light limited our comparisons to the stronger lines of each element.

What elements do the numerous other lines in the star represent? Some of them are probably due to the vapours of other *terrestrial* elements, which we have not yet compared with these stars. But may not some of these lines be the signs of primary forms of matter unknown upon the earth? Elements new to us may here show themselves, which form large and important series of compounds, and therefore give a special character to the physical conditions of these remote systems. In a similar manner the spectra of terrestrial substances have been compared with several other stars. The results are given in the diagrams. Five or six elements have been detected in Betelgeux. Ten other elements do not appear to have a place in the constitution of this star.

β Pegasi	contains	sodium, magnesium, and perhaps barium;
Sirius	,,	sodium, magnesium, iron, and hydrogen;
α Lyræ (Vega)		sodium, magnesium, iron;
Pollux	,,	sodium, magnesium, iron.

About sixty other stars have been examined, all of which appear to have some elements in common with the sun and earth, but the selective grouping of the elements in each star is probably peculiar and unique.

A few stars, however, stand out from the rest, and appear to be characterized by a peculiarity of great significance. These stars are represented by Betelgeux and β Pegasi. The general grouping of the lines of absorption in these stars is peculiar, but the remarkable and exceptional feature of their spectra is the absence of the two lines which indicate hydrogen, one line in the red, and the other in the green. These lines correspond to Fraunhofer's C and F. The absence of these lines in some stars, shows that the lines C and F are not due to the aqueous vapour of the atmosphere.

We hardly venture to suggest that the planets which may surround these suns probably resemble them in not possessing the important element, hydrogen. To what forms of life could such planets be adapted? Worlds without water! A power of imagination like that possessed by Dante would be needed to people such planets with living creatures.

It is worthy of consideration that, with these few exceptions, the terrestrial elements which appear most widely diffused through the host of stars are precisely some of those which are essential to life such as it exists upon the earth—namely, hydrogen, sodium, magnesium, and ron. Besides, hydrogen, sodium, and magnesium represent the ocean, which is an essential part of a world constituted like the earth.

We learn from these observations that *in plan of structure* the stars, or at least the brightest of them, resemble the sun. Their light, like that of the sun, emanates from intensely white hot matter, and passes through an atmosphere of absorbent vapours. With this unity of general plan of structure, there exists a great diversity amongst the individual stars. Star differs from star in chemical constitution. May we not believe that the individual peculiarities of each star are essentially connected with the special purpose which it subserves, and with the living beings which may inhabit the planetary worlds by which it may possibly be surrounded.

When we had obtained this new information respecting the *true nature* of the stars, our attention was directed to the phenomena which specially distinguish some of the stars.

COLOURS OF THE STARS.

When the air is clear, especially in Southern climes, the twinkling stars do not all resemble diamonds; here and there may be seen in beauteous contrast *richly-coloured gems*.

The colour of the light of the stars which are bright to the naked eye is always some tint of *red*, *orange*, or *yellow*. When, however, a telescope is employed, in close companionship with many of these ruddy and orange stars, other fainter stars become visible, the colour of which may be *blue*, or *green*, or *purple*.

Now it appeared to us to be probable that the origin of these differences of colour among the stars may be indicated by their spectra.

Since we had found that the source of the light of the stars is incandescent solid or liquid matter, it appeared to be very probable that at the time of its emission the light of all the stars is white alike. The colours observed amongst them must then be caused by some modification suffered by the light after its emission.

Again, it was obvious that if the dark lines of absorption were more numerous, or stronger, in some part of the spectrum, then those colours would be subdued in power, relatively to the colour in which few lines only occur. These latter colours remaining strong, would predominate, and give to the light, originally white, their own tints.

These suppositions have been confirmed by observations.

Mr. Ladd will throw upon the screen the spectrum of Sirius, which may be taken as an illustration of the *stars the light of which is white*.

As might be expected, the spectra of these stars are remarkable for their freedom from strong groups of absorption-lines. The dark lines, though present in great number, are all, with one exception, very thin and faint, and too feeble to modify the original whiteness of the light. The *one* exception consists of three very strong single lines: one line corresponding to Fraunhofer's C, one to F, and the other near G. Two of these certainly, indicate the presence of hydrogen. This peculiarity, which seems invariably connected with colourless stars, is very suggestive, and invites speculation. May it be a sign of a temperature of extreme fierceness?

Let us now examine the spectrum of an *orange star*.

This diagram represents the spectrum of the brighter of the two stars which form the double star, *α Herculis*. In the spectrum of this star the green and blue parts of the light, and also the deep red, are subdued with strong groups of lines, while the orange and yellow rays preserve nearly their original intensity, and therefore predominate in the star's light.

The question yet remained to be answered: Would the faint telescopic stars, which are *blue*, *green*, and *purple*, and which are never found alone in the heavens, but always under the protection of a strong *ruddy* or *orange* star, furnish spectra in accordance with this theory?

With some little difficulty, and by means of a special arrangement of the spectrum apparatus, we succeeded in observing the spectra of the components of some double stars. There will now be thrown upon the screen the well-known double star β Cygni. In a large telescope the colours of the two stars are beautifully contrasted, as they now appear upon the screen. The spectra of these stars are now shown. The upper spectrum represents the orange star, the lower one that of its beautiful blue but feeble companion. In the orange star you observe that the dark lines are strongest and most closely grouped in the blue and violet parts of the spectrum, and the orange rays therefore, which are comparatively free from lines, predominate.

In the delicate blue companion, the strongest groups of lines are found in the yellow, orange, and in part of the red. In the arrangement of these groups of lines we have a sufficient cause for the predominance of the other portions of the spectrum which unite in the eye to give the blue purple colour of the light of this star.

We have, therefore, shown that the colours of the stars are produced by the vapours existing in their atmosphere. The chemical constitution of a star's atmosphere will depend upon the elements existing in the star and upon its temperature.

VARIABLE STARS.

The brightness of many of the stars is found to be variable. From night to night, from month to month, or from season to season, their light may be observed to be continually changing, at one time increasing, at another time diminishing. The careful study of these variable stars, by numerous observers, has shown that their continual changes do not take place in an uncertain or irregular manner. The greater part of these remarkable objects wax and wane in accordance with a fixed law of periodic variation which is peculiar to each.

We have been seeking for some time to throw light upon this strange phenomenon by means of observation of their spectra. If in any case the periodic variation of brightness is associated with *physical changes* occurring in the star, we might obtain some information by means of the prism. Again, if the diminution in brightness of a star should be caused by the interposition of a dark body, then, in that case, if the dark body be surrounded with an atmosphere, its presence might possibly be revealed to us, by the appearance of additional lines of absorption in the spectrum of the star when at its minimum. One such change in the spectrum of a variable star we believe we have already observed.

Betelgeux is a star of a moderate degree of variability. When this star was at its maximum brilliancy in February last, we missed a group of lines, the exact position of which we had determined with great accuracy by micrometric measurements some two years before.

We have observed the spectra of several variable stars at different phases of their periodic variation, but our results are not yet complete.

It is worthy of notice that the variable stars which have a ruddy or an orange tint possess spectra analogous to that of Betelgeux and β Pegasi.

As an example of this group of variable stars, Mr. Ladd will throw upon the screen the spectrum of μ Cephei when at its maximum.

TEMPORARY STARS.

With the variable stars modern opinion would associate the remarkable phenomena of the so-called *new stars* which occasionally, but at long intervals, have suddenly appeared in the sky. But in no case has a permanently bright star been added to the heavens. The splendour of all these objects was temporary only, though whether they died out or still exist as extremely faint stars is uncertain. In the case of the two modern temporary stars, that seen by Mr. Hind in 1845, and the bright star recently observed in Corona, though they have lost their ephemeral glory, they still continue as stars of the tenth and eleventh magnitudes.

The old theories respecting these strange objects must be rejected. We cannot believe with Tycho Brahe that objects so ephemeral are *new creations*, nor with Riccioli that they are stars brilliant on one side only, which have been suddenly turned round by the Deity. The theory that they have suddenly darted towards us with a velocity greater than that of light, from a region of remote invisibility, will not now find supporters.

On the 12th May last a star of the second magnitude suddenly burst forth in the constellation of the Northern Crown. Thanks to the kindness of the discoverer of this phenomenon, Mr. Birmingham, of Tuam, I was enabled, conjointly with Dr. Miller, to examine the spectrum of this star on the 16th May, when it had not fallen much below the third magnitude.

I ought to state that Mr. Barker, of London, Canada West, who announced an observation of this star on 14th May in the *Canadian Free Press*, now claims to have seen the star on May 4th, and states that it increased in brilliancy up to May 10th, when it was at its maximum.

The spectrum of this star consists of two distinct spectra. One of these is formed by these four bright lines. The other spectrum is analogous to the spectra of the sun and stars.

These two spectra represent two distinct sources of light. Each spectrum is formed by the decomposition of light, which is independent of the light which gives birth to the other spectrum.

The continuous spectrum, crowded with groups of dark lines, shows that there exists a photosphere of incandescent solid or liquid matter. Further, that there is an atmosphere of cooler vapours, which give rise by absorption to the groups of dark lines.

So far, the constitution of this object is analogous to that of the sun and stars, but in addition there is the second spectrum, which consists of bright lines. There is therefore a second and distinct source of light, and this must be, as the character of the spectrum shows, *luminous gas*. Now the position of the two principal of the bright lines of this spectrum informs us that one of the luminous gases is *hydrogen*. The great brightness of these lines shows that the luminous gas is hotter than the photosphere. These facts, taken in connexion with the suddenness of the outburst of light in the star, and its immediate very rapid decline in brightness, *from the 2nd mag. down to the 8th mag. in twelve days*, suggested to us the startling speculation that *the star* had *become suddenly enrapt in the flames of burning hydrogen*. In consequence, it may be, of some great convulsion, enormous quantities of gas were set free. A large part of this gas consisted of hydrogen, which was burning about the star in combination with some other element. This flaming gas emitted the light represented by the spectrum of bright lines. The

increased brightness of the spectrum of the other part of the star's light may show that this fierce gaseous conflagration had heated to a more vivid incandescence the solid matter of the photosphere. As the free hydrogen became exhausted the flames gradually abated, the photosphere became less vivid, and the star waned down to its former brightness.

We must not forget that light, though a swift messenger, requires time to pass from the star to us. The great physical convulsion which is new to us is already an event of the past with respect to the star itself. For years the star has existed under the new conditions which followed this fiery castastrophe.

NEBULÆ.

I pass now to objects of another order.

When the eye is aided by a telescope of even moderate power, a large number of faintly luminous patches and spots come forth from the darkness of the sky, which are in strong contrast with the brilliant, but point-like images of the *stars*. A few of these objects may be easily discerned to consist of very faint stars closely aggregated together. Many of these strange objects remain, even in the largest telescopes, unresolved into stars, and resemble feebly shining clouds, or masses of phosphorescent haze. During the last 150 years, the intensely important question has been continually before the mind of astronomers, "What is the true nature of these faint, comet-like masses?"

The interest connected with an answer to this question has much increased, since Sir William Herschel suggested that these objects are portions of the primordial material out of which the existing stars have been fashioned, and further that in these objects we may study some of the stages through which the suns and planets pass in their development from luminous cloud.

The telescope has failed to give any certain information of the nature of the nebulæ. It is true that each successive increase of aperture has resolved more of these objects into bright points, but at the same time, other fainter nebulæ have been brought into view, and fantastic wisps and diffused patches of light have been seen, which the mind almost refuses to believe can be due to the united glare of innumerable suns still more remote.

Spectrum analysis, if it could be successfully applied to objects so excessively faint, was obviously a method of investigation specially suitable for determining whether any essential physical distinction separates the nebulæ from the stars.

I selected for the first attempt, in August, 1864, one of the class of small but comparatively bright nebulæ.

My surprise was very great, on looking into the small telescope of the spectrum apparatus, to perceive that there was no appearance of a band of coloured light, such as a star would give, but in place of this, there were three isolated *bright lines* only.

This observation was sufficient to solve the long agitated inquiry in reference to this object at least, and to show that it was not a *group of stars*, but a *true nebula*.

A spectrum of this character, so far as our knowledge at present extends, can be produced only by light, which has emanated from matter in the *state of gas*. The light of this nebula, therefore, was not emitted from incandescent solid or liquid matter, as is the light of the sun and stars, but from *glowing or luminous gas*.

It was of importance to learn, if possible, from the *position* of these bright lines, the chemical nature of the gas or gases of which this nebula consists.

Measures taken by the micrometer of the most brilliant of the bright lines showed that this line occurs in the spectrum very nearly in the position of the brightest of the lines in the spectrum of nitrogen. The experiment was then made of comparing the spectrum of nitrogen directly with the bright lines of the nebula. I found that the brightest of the lines of the nebula *coincided* with the strongest of the group of lines which are peculiar to nitrogen. It may be, therefore, that the occurrence of this one line only indicates a form of matter more elementary than nitrogen, and which our analysis has not yet enabled us to detect.

In a similar manner the faintest of the lines was found to coincide with the green line of hydrogen.

The middle line of the three lines which form the spectrum of the nebula does not coincide with any strong line in the spectra of about thirty of the terrestrial elements. It is not far from the line of barium, but it does not coincide with it. Besides these bright lines there was an also exceedingly faint continuous spectrum. The spectrum had no apparent breadth, and must therefore have been formed by a minute point of light. The position of this faint spectrum, which crossed the bright lines about the middle of their length, showed that the bright point producing it was situated about the centre of the nebula. Now this nebula possesses a minute but bright nucleus. We learn from this observation that the matter of the nucleus is almost certainly not in a state of gas, as is the material of the surrounding nebula. It consists of opaque matter, which may exist in the form of an incandescent fog of solid or liquid particles.

The new and unexpected results arrived at by the prismatic examination of this nebula showed the importance of examining as many as possible of these remarkable bodies. Would all the nebulæ give similar spectra? Especially it was of importance to ascertain whether those nebulæ which the telescope had certainly resolved into a close aggregation of bright points would give a spectrum indicating gaseity.

The observation with the prism of these objects is extremely difficult, on account of their great faintness. Besides this, it is only when the sky is very clear and the moon is absent that the prismatic arrangement of their light is even possible. During the last two years I have examined the spectra of more than sixty nebulæ and clusters. These may be divided into two great groups. One group consists of the nebulæ which give a spectrum similar to the one I have already described, or else of one or two only of the three bright lines. Of the six objects examined about one-third belong to the class of gaseous bodies. The light from the remaining forty nebulæ and clusters becomes spread out by the prism into a spectrum which is *apparently* continuous.

I will exhibit upon the screen a few of the more remarkable of the nebulæ *which are gaseous in their constitution*.

This photograph is from a drawing by Lord Rosse of a small nebula in Aquarius. (I. H. IV.)

We have here a gaseous system which reminds the observer of Saturn and his rings. The ring is seen edgeways.

The three bright lines represent the spectrum into which the light of this object is resolved by the prism.

In this other nebula we find probably an analagous general form of structure. In consequence of the nebula lying in a different position to us its ring is seen not edgeways, but open on the flat.

The spectrum consists of three bright lines.

The arrangement of the streams of light in the object now on the screen suggests a spiral structure. This nebula is remarkable as the only one in which, in addition to the three bright lines, a fourth line was also seen.

The most remarkable, and possibly the nearest to our system, of the nebulæ presenting a *ring formation*, is the well-known Annular Nebula in Lyra. The spectrum consists of one bright line only. When the slit of the instrument crosses the nebula, the line consists of two brighter portions corresponding to the sections of the ring. A much fainter line joins them which shows that the faint central portion of the nebula has a similar constitution.

A nebula remarkable for its large extent and peculiar form, is that known as the *Dumb-bell Nebula*. The spectrum of this nebula consists of one line only. A prismatic examination of the light from different parts of this object showed that it is throughout of a similar constitution.

The most widely known, perhaps, of all the nebulæ is the remarkable cloud-like object in the sword-handle of Orion.

This object is also gaseous. Its spectrum consists of three bright lines. Lord Rosse informs me that the bluish-green matter of the nebula has not been resolved by his telescope. In some parts, however, he sees a large number of very minute *red* stars which, though apparently connected with the irresolvable matter of the nebula, are yet doubtless distinct from it. These stars would be too faint to furnish a visible spectrum.

I now pass to some examples of the other great group of Nebulæ and Clusters.

All the true *Clusters*, which are resolved by the telescope into distinct bright points, give a spectrum, which does not consist of separate bright lines, but is *apparently* continuous in its light. There are many *nebulæ* which furnish a similar spectrum.

I take as an example of these nebulæ, the great nebula in Andromeda, which is visible to the naked eye, and is not seldom mistaken for a comet. The spectrum of this nebula, though apparently continuous, has some suggestive peculiarities. The whole of the red and part of the orange are wanting. Besides this character, the brighter parts of the spectrum have a very unequal and mottled appearance.

It is remarkable that the easily resolved cluster in Hercules has a spectrum precisely similar. The prismatic connexion of this cluster with the nebula in Andromeda is confirmed by telescopic observation. Lord Rosse has discovered in this cluster, dark streaks or lines similar to those which are seen in the nebula in Andromeda.

In connexion with these observations, it was of great interest to ascertain whether the broad classification afforded by the prism of the nebulæ and clusters would correspond with the indications of resolvability furnished by the telescope. Would it be found that all the *unresolved* nebulæ are *gaseous*, and that those which give a *continuous spectrum* are *clusters of stars*?

Lord Oxmantown has examined all the observations of the 60 nebulæ and clusters in my list, which have been made with the great reflecting telescope erected by his father the Earl of Rosse.

The results are given in this diagram:—

	Continuous Spectrum.	Gaseous Spectrum.
Clusters	10	0
Resolved, or Resolved?	5	0
Resolvable, or Resolvable?	10	6
Blue or Green, no resolvability, no resolvability seen	0 / 6	4 / 5
	31	15
Not observed by Lord Rosse	10	4
	41	19

Considering the great difficulty of successful telescopic observation of these objects, the correspondence between the results of prismatic and telescopic observation may be regarded as close and suggestive.

Half of the nebulæ which give a continuous spectrum have been resolved, and about one-third more are probably resolvable; while of the gaseous nebulæ *none have been certainly resolved*, according to Lord Rosse.

The inquiry now presses itself upon us, What superstructure of interpretation have we a right to raise upon the new facts with which the prism has furnished us?

Is the existence of the gaseous nebula an evidence of the reality of that primordial nebulous matter required by the theories of Sir William Herschel and Laplace?

Again, if we do not accept the view that these nebulæ are composed of portions of the original elementary matter out of which suns and planets have been elaborated, what is the cosmical rank and relation which we ought to assign to them?

As aids to a *future* determination of these great questions I will refer in a few words to some other observations.

COMETS.

There are objects in the heavens which occasionally, and under some conditions, resemble closely some of the nebulæ. In some positions in their orbits some of the comets appear as round vaporous masses, and, except by their motion, cannot be distinguished from nebulæ. Does this occasional general resemblance indicate a similarity of nature? If such be the case, if the material of the comets is similar to that of the nebulæ, then the study of the wonderful changes which comets undergo in the neighbourhood of the sun, may furnish useful information for a more correct interpretation of the structure and condition of the nebulæ. In 1864, Donati found that the spectrum of a comet visible in that year consisted of *bright lines*.

Last January a small telescopic comet was visible. Its appearance in a large telescope is represented on the screen. It was a nearly circular, very faint vaporous mass. Nearly in the centre, a small and rather dim nucleus was seen. When this object was viewed in the spectroscope, two spectra were distinguished. A very faint continuous spectrum of the coma showing that it was visible by reflecting solar light. About the middle of this faint spectrum a bright point was seen. This bright point is the spectrum of the nucleus, and shows that its light is different from that of the coma. This short bright line indicates that the nucleus of this comet was self-luminous, and further, the position of this line of the spectrum suggests that *the material of the comet was similar to the matter of which the gaseous nebulæ consist*.

MEASURES OF THE INTRINSIC BRIGHTNESS OF THE NEBULÆ.

It appeared to me that some information of

the nature of the nebulæ might be obtained from observations of another order. If physical changes of the magnitude necessary for the conversion of the gaseous bodies into suns are now in progress in the nebulæ, surely this process of development would be accompanied by marked changes in the intrinsic brightness of their light, and in their size.

Now since the spectroscope shows these bodies to be continuous masses of gas, it is possible to obtain an approximate measure of their *real brightness*. It is known that as long as a distant object remains of sensible size, its brightness remains unaltered. By a new photometric method I found the *intrinsic* intensity of the light of three of the gaseous nebulæ in terms of a sperm candle burning at the rate of 158 grains per hour :—

Nebula No. 4,628	$\frac{1}{1508}$	th part of the intensity of the candle.
Annular Nebula in Lyra	$\frac{1}{6032}$	nd " " "
Dumb-bell Nebula	$\frac{1}{19604}$	th " " "

These numbers represent, not the *apparent* brightness only, but the *true brightness* of these luminous masses, except so far as it may have been diminished by a possible power of extinction existing in cosmical space, and by the absorption of our atmosphere. It is obvious that similar observations made at considerable intervals of time may show whether the light of these objects is undergoing increase or diminution, or is subject to a periodic variation.

If the Dumb-bell Nebula, the feeble light of which is not more than the one twenty-thousandth part of that of a candle, be in accordance with popular theory a *sun-germ*, then it is scarcely possible to put in an intelligible form the enormous number of times by which its light must increase before this faint nebula, feebler now in its glimmering than a rushlight, can rival the dazzling splendour of our sun.

MEASURES OF THE NEBULÆ.

Some of the nebulæ are sufficiently defined in outline to admit of accurate measurement. By means of a series of micrometric observations it will be possible to ascertain whether any considerable alteration in size takes place in nebulæ.

METEORS.

Mr. Alexander Herschel has recently succeeded in subjecting another order of the heavenly bodies to prismatic analysis. He has obtained the spectrum of a bright meteor, and also the spectra of some of the trains which meteors leave behind them. A remarkable result of his observations appears to be that sodium in the state of luminous vapour is present in the trains of most meteors.

CONCLUSION.

In conclusion, the new knowledge that has been gained from these observations with the prism may be summed up as follows :—

1. All the brighter stars, at least, have a structure analogous to that of the sun.
2. The stars contain material elements common to the sun and earth.
3. The colours of the stars have their origin in the chemical constitution of the atmospheres which surround them.
4. The changes in brightness of some of the variable stars are attended with changes in the lines of absorption of their spectra.
5. The phenomena of the star in Corona appear to show that in this object at least great physical changes are in operation.
6. There exist in the heavens *true nebulæ*. These objects consist of luminous gas.
7. The material of comets is very similar to the matter of the gaseous nebulæ, and may be identical with it.
8. The bright points of the star-clusters may not be in all cases stars of the same order as the separate bright stars.

It may be asked what cosmical theory of the origin and relations of the heavenly bodies do these new facts suggest? It would be easy to speculate, but it appears to me that it would not be philosophical to dogmatize at present on a subject of which we know so very little. Our views of the universe are undergoing important changes ; let us wait for more facts with minds unfettered by any dogmatic theory, and therefore free to receive the obvious teaching, whatever it may be, of new observations.

Star differs from star in glory, each nebula and each cluster has its own special features ; doubtless in wisdom and for high and important purposes the Creator has made them all.

Section A.—Mathematical and Physical Science.

On the Heat Attained by the Moon under Solar Radiation, by J. Park Harrison, M.A.

The author stated that when he brought forward the subject of lunar insolation a year ago, he showed by a simple diagram that the surplus or accumulated heat in the moon beyond what it radiates off into space, or to other matter, owing to the long-continued action of the sun's rays upon her crust would necessarily reach its maximum several days after the date of complete illumination, the mean duration of solar radiation for the two periods of first and third quarters being, in fact, in the proportion 4·25 : 11·25—(viz. $\frac{1+7\cdot50 \text{ days,}}{2}$ and $\frac{7\cdot50+15 \text{ days.}}{2}$) Consequently the periods when the moon's surface directly opposite to us is longest withdrawn from, or exposed to the sun's heat, or, in other words, the days on which the moon completes her first and third quarters, would be not far removed from the days of her maximum and minimum temperature. The author has since learnt that Herr Althaus, some few years back, approximately estimated the temperature of the moon at 840 deg. F. *on the 22nd day of the lunation*—seven days after the day of full moon, and very near the time indicated by the diagram. His method was to measure the sun's radiation by the pyrheliometer, and then, applying the result to the moon, he deduced from the extent of her area the amount of heat intercepted ; the measure of the moon's capacity for heat was that of quartz. Assuming this deduction to be correct, the heat attained by the moon would approach very closely the temperature at which iron appears red at twilight, and it exceeds the fusing points of tin and lead. Unfortunately, the estimate cannot be compared with that made by Sir John Herschel, which applies to the moon's heat at the period of complete illumination, and not to the period of maximum absorption. It is true that bodies heated to very high temperatures cool both in air and vacuo with great rapidity ; yet it has been proved that the rate of cooling is greatest in air, by reason of its conduction and convection of heat. This is one of the laws laid down by Dulong and Petit ; and the author has recently satisfied himself of the truth of it by experiments made in the large receiver of the air-pump at Kew ; as well as by observations made with black bulb thermometers enclosed in glass globes, both exhausted and filled with air. It results that the absence of an atmosphere may, in the case of the moon, favour an accumulation of heat, though in a different manner from that in which the presence of air and vapour affects the earth ; where the slight heat stored up in her crust would be speedily lost if it were not for the counter-radiation to her surface from cloud and vapour. On a view of the whole case at the present time, there would seem to be reason to believe that the sun's rays must penetrate the moon's crust to a depth that would prevent the possibility of her acquired heat being easily or speedily dissipated.

Section B.—Chemical Science.

On an Extraordinary Iron-stone, by Dr. T. L. Phipson, F.C.S.

A journey which the author made in Waldeck, during the summer of last year, furnished several new and interesting facts ; and amongst others the discovery, about twelve English miles to the south-west of the mineral springs of Wildungen, of a very remarkable iron-stone lode in quartz rock. The geological features of this wild and beautiful country appear to be very similar to those of the Hartz district. The altered greenstone and clayslate rocks are traversed by numerous lodes of lead-ore, barytine, copper-ore, and iron-stone. The latter is principally red hematite of very fine quality ; but in one locality, about eight miles from Neubau, the author found a fine red quartz rock penetrated by a brilliant steel-looking iron-stone, appearing more like the metal itself than an ore. On being analysed, it gave 57 per cent. of per-oxide of iron, and 23 per cent. of magnetic oxide, 19 of quartz with traces of manganese, &c. It yields iron of a very superior quality, but is exceedingly difficult to smelt. Nothing similar to it has before been met with. Dr. Phipson states that the red hematite iron-ores of this district all contain a small amount of magnetic oxide, in which they differ from our English hematites, the latter rarely yielding more than the smallest trace ; from which we may conclude that they have been formed in different geological circumstances.

On the Purification of Terrestrial Drinking Waters by Neutral Sulphate of Alumina, by William Birt.

An abundant supply of pure water for drinking and culinary purposes has always been considered a matter of importance. Hence in building a house or choosing a residence, one of the first questions is—what is the quality of the water? and happy is he who can faithfully say that he has got a pure supply.

Generally, in the country, pure water can be procured at moderate depths, but this is not so in large towns and cities. As a rule, all surface wells ultimately become defiled, and the only supply of water to be had is that which has been taken from rivers or ponds by Water Companies, and distributed by their mains to the public. Such waters (as is well known) require some purifying before being fit for human use. The most obvious and general method is to strain or filter the water. For doing this, many sorts of filters, and some of great merit, are used. But unfortunately, however, admirable a filter may be, it must sooner or later get fouled up by its own action, which stops the defilement inside, and which, accumulating more and more, imparts to what water goes through it a peculiar vapid, disagreeable taste.

Having had some experience in these matters, it occurred to me that the brown colouring matter which is dissolved in river and pond waters, and which it is the object of filtering to separate, might be thrown down by precipitation, without filtering at all ; and after many trials I fixed upon the neutral sulphate of alumina as the most suitable precipitating agent. This salt is made by saturating pure hydrated alumina with sulphuric acid.

Section C.—Geology.

On the Vast Areas in England and Wales in which no Productive Coal Beds can reasonably be looked for, by Sir Roderick Murchison, F.R.S.

After alluding to Mr. Goodwin Austen's theory that coal measures might be found under London and the south-eastern part of England, Sir Roderick said that reflection upon the order and nature of the rocks which surround the south-eastern counties of England, whether on the coast of France, the Channel Islands, or the western, midland, or north-eastern counties of England, had led him to an opposite conclusion—viz., that no productive coal measures can be look for in the counties of Essex, Kent, Sussex, Middlesex, Herts, Hants, Bucks, Oxfordshire, Suffolk, Norfolk, and the eastern counties. To this hopeless list must be added all the numerous tracts wherein rocks older than the Carboniferous rise to the surface, as in the greater part of Wales and Hertfordshire, in all of which coal cannot possibly be found. After alluding to the data afforded by observations in France, which had led to the theory he had mentioned, he said the Carboniferous strata of Valenciennes constituted a portion of the southern edge of the great coal basin of Belgium, in which country, together with the Devonian limestones, they form undulations. The position of these coal strata which exist in France, and which at Valenciennes dip at a high angle to the north, have also been found to extend on the stripe for a certain distance beneath the Cretaceous rocks pointing towards the British Channel. By trials through these Cretaceous rocks and overlying deposits, these same coal strata had been found to extend beyond Bethune. In all the borings which had been made, however, in the neighbourhood of Fleckenelle, Devonian limestone existed, and grits had been reached, the coal being thus completely cut out. After a reference to the map of Messrs. Elie Du Beaumont and Dufresney, he said the limits of the coal-bearing strata on the north and south of the Carboniferous zone had been ascertained by trials, all of which show that the Devonian rocks flank on each side this tongue of coal measures, the extreme point of which is at Fleckenelle. Between that village and Boulogne, Devonian rocks only are found under the Secondary deposits. All the practical French geologists with whom he had conversed were of opinion that the coal basin of Valenciennes and Belgium terminated, as far as any productive value was concerned, a few miles from Bethune. The coal measures thus thinned out as they approached the British Channel and he held that there were no better reasons for hoping for better conditions through the southern counties of England. Judging from well-ascertained data—viz., that the Secondary rocks of the western and central parts of England which lie beneath the chalk, such as the Frias, Lias, and Oolites thin out in their extension, or as they incline to the south-east, as well proven by Mr. Hull—still it is by no means impossible

that the part of the Oolite series which appears in the cliffs north of Boulogne may be continued under the Cretaceous and Wealden rocks of Middlesex, Sussex, and Kent. The question then is, what will the fundamental rock prove to be in those districts if it should be searched for? Probably either Carboniferous limestone, without any productive coal, or still more probably Devonian rocks only. If we follow the course of the older rocks in France, southwards from the Boullonois, everywhere Devonian rocks have only been found, and proceeding through Normandy and Brittany, we find that the Jurassic rocks repose at once on Lower Silurian rocks, to the total exclusion of everything Carboniferous or Devonian; whilst in the Channel Islands nothing but crystalline rocks of granite and gneiss slate occur, with no signs of any intermediate strata between them and the Wealden Cretaceous rocks of the Isle of Wight and Hampshire. Proceeding to trace the line of older rocks which separates the south-eastern from the south-western counties, we see the Devonian rocks of the Quantock Hills in Somerset overlaid by new-laid sandstone, without a sign of anything carboniferous; and when we advance northwards to the Mendip Hills the phenomena we there meet with are indicative of the hopelessness of seeking for any productive coal measures between these hills and Straits of Dover—*i.e.*, in Wilts, Hants, Sussex, Kent, Surrey, Middlesex, Essex, and Herts. Far on the west the mountain limestone forms the outward eastern guide of the great Somerset and Bristol coal basin from Wells and Elm, near Frome, on the south, to Chipping Sodbury, Nickwar, and to near Fortnorth on the north, and throughout a distance of about 35 miles. This, which is the unproductive bottom rock of every coal-bearing stratum in the south of England and Wales—*i.e.*, Carboniferous limestone, with traces of millstone grit—is everywhere and at once surrounded on the east by thin courses of new red, or by the Lias and Oolitic formations. He referred incidentally to the limestone beds near the Bristol coal basin, and went on to say: "It is on the highly-inclined and upturned edges of mountain limestone that the Secondary rocks lying to the east at once repose, without any portion of those carbonaceous deposits which are so thickly spread out to the west of this land, whether in the Bristol basin properly so defined, or in the Forest of Dean, or in the great south Welsh coal-field. So much for nearly the whole length and breadth of the country lying to the outermost band of all the Carboniferous rocks of the south of England, including the Forest of Dean, to the east of which the non-existence of any coal measures is rendered more striking, because, in addition to a run of mountain limestone wholly unproductive of coal, the Old Red Sandstone and Silurian rocks are interspersed. The same data will apply to the vale of the Severn, the Cotteswold Hills, and the whole country south of Cheltenham. Who, for example, would speculate on the chance of finding productive coal north of Newent in Gloucestershire, when it is known that on the west, the only outcrop is in the miserably poor lone bed which occurs in that locality? Equally absurd would it be to look for coal in any of those parts of the Severn valley of Gloucester and Worcester which lie to the east of Malvern Hills, where the new red sandstone lies directly upon the crystalline and other rocks of that range. Extending this view, it seems to me that the Malvern Hills to the south-west and Charnwood Forest on the north-east, each consists of rocks of much higher antiquity, from the salient promontories of the old coast line to the east of which there can be little or no hope of finding productive coal measures. Even if it should be suggested that the southern ends of the Staffordshire and Leicestershire fields may have a south-easterly continuation, which is by no means forbidden, still the enormous accumulation of rocks would put any reliable estimate out of the question as to the working of coal. On the other hand, there can be little doubt that vast supplies of coal will eventually be worked to the north and west of those fields, from beneath the Permian and New Red Sandstone formations in the Midland Counties. Thus the red sandstone tracts between Wolverhampton and Coal Brook Dell in Cheshire, between the Flintshire core and the great Lancaster field, and over vast areas similarly circumstanced, there can be little doubt that coal will ultimately be worked—a view which I strongly advocated thirty years ago." He returned to the consideration of the case as respects the wide area in which London lies: the first ancient rocks we meet with are the slates of Charnwood Forest, which are admitted to be of Cumbrian or infra-Silurian age. To the west of these lies the Leicester coal tract, as well as other coal-fields of the central counties; but to the east, nothing is seen but Secondary rocks, from the New Red Sandstone and Lias to the Oolites and Cretaceous rocks. Who, then, with such an outcrop to the west, would sink for coal in any of the counties lying to the east or south-east of Charnwood Forest and Hart-hill? The recent well sinkings at Harwich have completely solved this problem. There the trial ended in the discovery beneath 1,025 feet of Cretaceous rocks, of a hard, slaty rock, with the lower Carboniferous limestone, evidently older than any coal-bearing stratum. Specimens of this rock are preserved in the Museum of Practical Geology, as a warning to those speculators who would search for coal in the eastern or south-eastern counties of England. He extended the reasoning employed to parts of Lincolnshire and the Riding of Yorkshire, as well as to a large portion of the North Riding of the latter county, and mentioned how, at Middlesborough, Mr. Vaughan, the ironmaster, sunk an Artesian well to the depth of 1,800 feet, and reached a body of rock salt, without reaching even the surface of the magnesian limestone through which the deep coal pits of the Earl of Durham are sunk to the extreme depth at which coal has hitherto been worked in that county. If, then, the coal should be prolonged under ground to the south of the Tees, and should pass under the Vale of Cleveland and the hills of the eastern Moorlands, what would be the depth at which it would have to be sought? On the banks of the Tees, west of Darlington, wherever the magnesian limestone forms the upper stratum, as at Coniscliffe, it is at once underlaid by unproductive millstone grit, which on the west lies upon mountain limestone, the productive coal measures between the millstone grit and the Permian rocks being entirely wanting, owing, he presumed, to an ancient elevation of the tract during the Lower Carboniferous period, so that no valuable vegetable or coal matter had ever had an existence in the tract extending from Barnard Castle on the Tees to the south of Harrogate. At the latter place, the Plumpton rocks and conglomerates, underlying the magnesian limestone, and forming the base of the Permian system, are seen to repose directly on unproductive millstone grit, which, in its turn, rests upon the great mountain limestone region of the western dales of Yorkshire. This was not merely his opinion, but that also of Professor Phillips, who has carefully surveyed the tract in question, and also that of many sound geologists. He alluded to Mr. Bradley's experimental borings, but was afraid they would be unsuccessful. To the south of Harrogate, the great coal-fields of Leeds and the West Riding appear with a full defined layer of millstone grit on the north. To the eastern boundary of the coal-fields there is a fair probability that they may be found to extend under the magnesian limestone, the red sandstone, and eventually be worked through those deposits when the coal found at shallower depths is exhausted—*i.e.*, in the environs of Doncaster and other places. Proceeding southwards, we find a most satisfactory and progressive thickening of the coal which is beneath that rock. In the tract between Mansfield and Nottingham, the coal strata of Derbyshire, rich as they are, become thicker and richer as they dip to the east under the magnesian limestone. The coal pits which have already been sunk along this band at Hucknall and other places, are very satisfactory proofs of the certainty of now finding excellent coal, superior indeed in quality and dimensions to most of the coal beds of Derbyshire, in position and in tracts where no one, a few years ago, except geologists, thought of their existence. Probably at some distant day, and when the more easily attainable coals are worked out, under the magnesian limestone, the mineral may be found under the hard red sandstone which occupies the south-western portion of Sherwood Forest, and that at depths which at present would render such operations unremunerative. These subjects would, he trusted, be duly inquired into by the Royal Coal Commission. His object was to exclude from the reasoning upon English coal-fields—whether rising to or near the surface, or attainable through overlying rocks, those hypotheses which are negatived by fair reasoning. When we exclude, as of necessity, 21,800 square miles, or nearly one-half of England and Wales, as consisting of rocks older than the coal measures, and also the southern and eastern counties, we have simply to proceed to form the best approximate estimate we can form of the amount of coal left in those fields which has been long worked, whether they be basins or upcast masses; and next, if the latter, what is the prospect of a profitable extraction of coal from our deep-seated beds by reaching them at certain depths beneath the superjacent Permian or other overlaying deposits, through which they have been upheaved to constitute coal-fields of the midland counties. The excluding from the inquiry into the present or probable future coal supply of England and Wales all that tract of crystalline and Palæozoic rocks which rise out from beneath the Carboniferous strata, and in which no trace of coal can ever be discovered, and also all those Secondary and Tertiary rocks beneath which, for the reasons given it is hopless to look for coal, it will be seen that the existing and possibly future supplies have, for all practical purposes, an approximately defined limit, and that they range over little more than one-eighth part of England and Wales, or an area of about 6,000 miles. Declining to express an opinion as to the direction of the accessible coal in Britain until a close survey, carried out with the view of determining that point, shall have been completed, he appreciated the anxious desire which is felt by all those persons who are interested in the future welfare of this country to have the subject fully and fairly inquired into; the more so, as the last inquiry made by Mr. Robert Hunt, under his direction, showed that the last year's consumption of coal reached the figure of nearly 100 millions of tons.

Professor PHILLIPS held that the country had no need to be dismayed at the statements made by Mr. Jevons.

Dr. PENGELLY said the question was, how long it would be possible to get coal in this country at less expense than they would get it from America.

Section D.—BIOLOGY.

Professor HUXLEY desired, in the first place, to explain what, in his judgment, was the object of the science called by a term which might be new to many—viz., Biology—to point out what was the scope of that science, and what were the objects of the persons who pursued it. He desired to explain, with the preliminary admission that his view might be entirely erroneous, the leading divisions of that science, how they grouped themselves, and how they stood in relation to other branches of knowledge. He intended to have provided himself with the egg of a bird and a seed—a bean or some such seed. He would ask the audience to imagine they were before him, and he would ask their attention to the contents of those two bodies. They would find no entire chick in the egg, nor an entire bean in the seed. They might find a certain rudimentary outline of the one and of the other, but the thing itself was assuredly not present. Imagine the egg to be exposed to the incubating action of the hen, and the seed to be planted in the ground, and supplied with moisture and such warmth as it requires. After a time, out of the apparently formless mass in the egg there would issue a creature full of life and activity, full even of the lower form of mental action, which would take the shape of a chick. By-and-bye it would grow up and become a fowl, passing through a succession of changes familiar to all. On the other hand, the bean would start up, throw out its leaves and flowers, and eventually become a bean-stalk, and give forth those products which proceed from such plants. What he wished to direct attention to was this, that in the whole of such changes thus proceeding from the single egg and single seed, there was a definite order and succession of forms. In these developments no account was taken of the causes. When the fowl arrived at maturity every one knew that it did not present a homogeneous mass; it consisted of vessels and fibres, and the study of this structure was called anatomy. It was anatomy, if the student dissected a body and found muscles and bones there, and it was studying a plant anatomically if it was ascertained that it consisted of bark or pith, or other matters. Since the eye of man had applied the microscope to anatomical investigation, there was a disposition to make a sub-division of anatomy; but even in this examination of animals and plants the student dealt simply with forms. There were many thousands of different kinds of animals and different kinds of plants, and in studying every animal and every plant in exactly the same way as they had studied the chick and the bean, it would be found that these multitudes of different anatomies had a certain relation one with another; they could be broken up into groups of things like one another, and things less like one another. A bean was much more like an oak than either of these was like a moss; a fowl was more like an eagle than a man; and a man was much more like four-footed animals than a crocodile. Not only was there a diversity of creatures, there was a diversity also in their nature and in their distribution. Nor was the

distribution confined to the existing state of things. One of the established facts was, that the earth was not the origin of yesterday, but that it has existed for millions and millions of ages, and through those ages there have been living things, exhibiting the same kind of properties as those the remains of which are found embedded in our old mud bottoms. Still in the study of these remains the student had to do with nothing but form, but this form established the existence of force. This form was force visible; this form so long as it existed was the appearance of force; the change of this form resulted from the predominance of one group of force over the other. Just as in every other branch of inquiry, there was a correlative kind of investigation running parallel to the inquiry he had just mentioned. After getting together the facts of development, the next inquiry was—how have they come about? And after considering the vast succession of life that has taken place, another legitimate inquiry was—how has this living matter come about at all, and what relation has it with other forms of force found in the universe? This branch of inquiry depended very much on the one he had previously referred to, inasmuch as the first inquiry furnished matter for the second. This inquiry into causes came under the broad head of physiology. There were two kinds of physiology, one having reference to individual beings—an inquiry into the properties of individual structures; and the other, which was comparatively new, had reference to the physiology of living things in general — an inquiry into the causes of the existence of living beings, the causes that have led to their modifications and to their becoming what they are. This branch of philosophy has been called into existence by Mr. Darwin. Whatever opinions might be held as to the value of the results Mr. Darwin had arrived at, no philosophical person or thinker worthy of the name, could doubt that his name would go down to posterity as a man who had organized this branch of inquiry, and had put it upon such a footing that every rational, thinking, careful man, could entertain that kind of inquiry. Such was a sketch of the relations of the different branches of biological science. Time did not permit him to trace out the progress of these different branches. The preparation required for the two branches was altogether different, and it was perfectly possible that a person should be very fully acquainted with the first branch, and be entirely ignorant as to the second. An indispensable preliminary to the study of physiology was a general knowledge of physics and chemistry. These considerations would sufficiently define the view he had advanced as to the relations of the different branches of biological science. Section D had left its old name of Zoology and Botany, and had taken that of Biology—the obvious reason for the change being that the section should treat of all those physical matters which are manifested by living beings. If there were such a thing as scientific education in this country, there might be some chance of the ideal of this section being attained, but let him say at once that anything like a systematic scientific education, such as exists in Germany and France, was out of the question. The University would not give the learning to persons who studied the sciences, and, in consequence, the public schools would not bring up boys to studies which they could not follow out at the University. So everything was at a standstill. If the minds of the youth of England were prepared by such education as might be within the reach of every boy of eighteen years of age, and disciplined in the limits of phyics and chemistry, it would be possible to attain the ideal of this section, by every person who attended it being beforehand instructed in the outlines of biology, and being allowed to take a more or less rational interest in any subject which may be brought before him. Vast numbers of persons who pursued the different branches of biological study were not only absolutely ignorant of the details of what their brethren were doing, but they had not sufficient general knowledge of the whole subject to take a rational interest in the points made by their brethren. The result was that the great mass of the proceedings of every scientific body were absolutely devoid of interest to the great proportion of its members.

Professor HUMPHRY defended the Universities.

DEPARTMENT OF ANTHROPOLOGY.

The Stature and Bulk of the Irish, and Degeneration of Race, by John Beddoe.

The writer observed that the recruiting statistics of the United Kingdom had for years been subjected to careful analysis, but until 1864, when the standard was lowered to 5 ft. 5 in., they were almost useless for the purposes of comparative Anthropology. He had been put in possession of particulars respecting all recruits, age 23 and upwards, inspected in Ireland since 1864. He had eliminated the very few men of English or Scotch birth appearing in the list, and added the very numerous Irishmen in England and Scotland, fixing on 23 as the lowest limit of age, growth after that period being rare. The whole number was 1,517—sufficient, probably, for the determination of the average stature of the classes that yielded recruits, but too few for some important objects which he had in view. The means yielded by the figures in the books were 5 ft. 7·25 in. for height, and 138·03 lbs. for weight. The average girth of the chest was 34·73 inches. The following were the averages for the several provinces, arranged in the inverse order of purity of blood, as denoted by the surnames of the recruits:—

Provinces, &c.	Stature. feet.	inches.	Weight. lbs.	No. of men.
Down, Antrim, & Derry	5	7·48	135·92	178
Dublin (city and county)	5	7·07	137·65	288
Rest of Ulster	5	7·29	137·60	220
Rest of Leinster	5	7·39	139·61	328
Munster	5	7·38	138·73	305
Connaught	5	6·90	137·10	198

Fifty Irishmen of the working classes, almost all Munster men, measured by Mr. Beddoe, averaged about 5 feet 6·7 inches in height, and 140lbs. in weight (naked). The Scotch recruits were about equal to those of Leinster and Munster in stature and weight, and exceeded in girth of chest both the English and the Irish, though the Welsh might equal them in that point. The Welsh recruits weighed heaviest, but their stature was considerably lower than that of the Irish. The English varied very much, but on the whole they did not quite equal even the Welsh in stature or the Irish in weight, which seemed mainly due to the low average of the recruits from the Metropolis and the manufacturing districts.

Section F.—ECONOMIC SCIENCE AND STATISTICS.

On the State and Prospects of the Rate of Discount with reference to the Recent Monetary Crisis, by Professor Leone Levi.

Having shown the great importance of the question as it affected the value of property generally, and indicated the immense losses produced by the sudden rise from 4 to 10 per cent., the author showed that 10 per cent. was the rate allowed during the reign of Henry VIII. and Queen Elizabeth; that in 1624 the legal rate was reduced to 8 per cent., during the Commonwealth to 6 per cent., and under Queen Anne, in 1714, to 5 per cent., at which rate it stood till the abolition of the Usury Laws in 1839, the Usury Laws and a comparative stagnation of business being the reason why the rate continued so long with little variation. During the pressure of 1839 the rate rose to 6 per cent., but it soon fell to 4 per cent., at which rate it was when the Bank Charter Act passed in 1844. Then the Bank of England resolved to make their rate of interest fluctuate with the rate of supply and demand of money, taking the state of their reserve as a guide. The paper then gave a summary view of the action of the Bank in this respect at different times, and the proportion between the reserve and liabilities to the rate of interest as follows:—

	Liabilities £	Reserve £	Proportion per cent.	Rate of Interest.
On the passing of the Act	13,305,512	9,632,790	67	2½ to 3½
October, 1847	15,073,986	3,075,115	20	8
May, 1852	18,724,558	12,069,240	64	2 to 2½
,, 1857	21,860,000	4,400,000	20	10
,, 1864	19,871,577	5,619,994	28	9
,, 1866	25,186,713	1,202,810	5	10
August, 1866	22,172,744	4,610,866	8	8

The Professor showed that the entire capital of the country was in a manner represented in the small reserve at the Bank, from the fact that all the banks keep their balances at the Bank, which are affected by the state of trade. The exclusion of the greater portion of bullion at the Bank from the reserve arose from the division of the Bank into two departments which received the amount to cover the extra issue of notes beyond the authorized amount. The rate of interest in the last 20 years has been progressively higher. From 1845 to 1849 the average was 3*l.* 11s. 7d.; 1850 to 1854, 3*l.* 5s. 11d.; 1855 to 1859, 4*l.* 11s. 8d.; 1860 to 1864, 4*l.* 15s. 3d.; to 1865, 4*l.* 16s. Compared with France and the United States, from 1831 to 1865, the rate in the latter country has been uniformly higher, frequently touching extreme limits, as in 1834, 15, 16, and 24 per cent.; in 1837 and 1839, 24 to 26 per cent. As between France and England in the last 37 years it was equal in both countries in 12 years; lower in this country in nine years; higher in this country in 15 years. What were the reasons, then, that with the great increase of wealth in this country the rate was higher now than 20 years ago, and higher in this country than in France? Some reasons were of a permanent character. First was the large increase of trade. While in 1849 the exports amounted to 63,000,000*l.*, in 1865 they were 165,860,000*l.* The imports in 1854 amounted to 152,000,000*l.*; in 1865 to 271,000,000*l.* Shipping increased in the same proportion. A second cause was the annual exportation of the precious metals to the East. A third was the immense numbers of joint-stock companies. In 1864 and 1865, 832 companies had been formed, with an authorized capital of 362,935,000*l.* Great amount of capital had been invested or prepared to be invested in public works. In the Session of 1865 the amount authorized to be raised was 126,000,000*l.*; in 1866 it was 175,500,000*l.* But some causes were of a temporary character, such as the bankruptcies of banks, an universal demand and want of confidence and eventual alarm among the commercial classes. The Bank Charter Act was considered by many to have a good share of influence in increasing the monetary pressure. It was questioned that the issues can at any time be in excess of actual wants, and the opinion was general that in any case discretionary power should exist somewhere to act as circumstances dictated. The author sympathized entirely with the view advocated on this subject by Mr. Tooke, John Stuart Mill, Neumarch, and others, and he was of opinion that the Bank Charter Act greatly intensified the panic and danger in time of crisis. But clearly it was idle to charge that with the blunder and rashness exhibited by the operations of many banks. What would restore the rate of interest to its normal rate would be a contraction of liabilities, the spreading of many of the public works over a large number of years. Trade was otherwise in a solid condition; prices were not high; speculation, if any existed, had been effectually checked. "To conclude," he said, "just as presence of mind and cheerfulness greatly contributed even in the midst of an epidemic to comparative preservation, so in a period of commercial panic the best safeguard to our own stability is the maintenance of a calm and undisturbed judgment (as far, indeed, as it is possible) in the ordinary course of business. There is a magic power in public confidence. No greater calamity could befall a commercial community than the sudden breaking asunder of this electric chain, which binds together all the great interests of the Empire. As far as we can see, the commerce of the country is solid and prosperous. If a cloud now and then obscures the horizon, it is only to make the sunshine more grateful and enduring; and even should a storm unhappily arise, destroying in its course the lighter craft—those, namely, which are but ill manned and ill prepared—we shall soon find that, better taught by experience, and even humbled by temporary misfortune, trade will once more enjoy a long season of progress and prosperity."

Section G.—MECHANICAL SCIENCE.

The PRESIDENT (Mr. Hawksley, C.E.), after pointing out that the inquiries of the section were limited for the most part to those branches of statics and dynamics which were or might be employed for the realization of so-called "practical ends," continued: Whatever may have been the advancement which civilized people have made in the arts of peace, it is only too evident that those peoples have even outstripped themselves in advancing the arts of destruction. We have seen in the great internal contention of our American brethren, and still later in the struggle in which several of the most important States of Europe have engaged, that war is no longer carried on by means of mere animal courage and brutal force. On the contrary, we perceive that the highest branches of mechanical science and the most refined processes and operations of the mechanical arts are resorted to by the modern warrior for the purposes of offence and defence, and we are taught by the logic of facts that the modern soldier must cease to remain a passive machine, but, on the contrary, must henceforth be trained as a skilled labourer, if, indeed, not even as a skilled artisan. At the present moment, the internal and external defences of this country are in a most unsatisfactory condition. Many endeavours have been made, and much money, reckoned by millions, has been expended, for the most part uselessly, in

endeavours to secure our coasts against the attacks of a foreign enemy. Forts have been erected where an adversary would never seek to land. Ships of an enormous size, and carrying enormous armaments, have been constructed, which can neither sail on shallow waters nor safely encounter a hurricane in deeper ones, which, with vast mechanical power on board, can yet not carry a sufficient quantity of coal to enable them to find their way to and act as protectors of our colonies, and which, for the same reason, are wholly unable to convey our merchantmen to those distant climes, without a safe communication with which the trade and commerce of England must be annihilated. Arsenals have been enlarged, if not constructed in situations in which they can only be secured from an enemy's fire by fortifications which it will require an additional army to man. Guns, each one larger or more elaborate than the last, have been invented, and constructed, and tried, and floating castles, each one heavier and uglier and more unmanageable and more useless (except for special applications) than the former one, have been built and cast upon the waters to resist them, yet, nearly all the many naval and military officers with whom he had come in contact acknowledged that this great country is not in a position to defend either herself or her colonies against a combined attack from more than one of those foreign friends we have heretofore recognized under a different appellation. Mr. Hawksley then directed attention to the many points of interest peculiar to Nottingham and its neighbourhood, and though he regretted that the town of Nottingham had not yet availed itself of the vast amount of mineral wealth within its reach, yet in the large undertakings at Butterly, Riddings, and other places, as well as the great extent to which the Midland coal-field is being wrought for the supply of distant countries, there were evidences of the growth of a local industry which, is yet in its infancy.

On the Influence of Friction in the Cylinder upon the Efficiency of Steam, by W. J. M. Rankine, LL.D., F.R.S.

The results arrived at by the author of this paper are based on the following principles: Let W be the indicated work of a given quantity of steam, without deducting loss by friction, and H the mechanical equivalent of the expenditure of heat required in order to do that work, so that $\frac{W}{H}$ is the efficiency of the steam without friction. Let F be the quantity of work lost through friction in the cylinder, and let the heat produced by that friction be wholly taken up by the steam. Then the work done is diminished to W—F, and the heat expended is diminished to H—F, so that the efficiency becomes $\frac{W-F}{H-F}$. The special way in which the friction takes effect in ordinary steam-engines is by diminishing the expenditure of heat required for the prevention of liquefaction in the cylinder.

Mr. Smythies thought that the formula given by Professor Rankine was scarcely correct, for the following reasons: The formula for the efficiency of steam $\frac{W-F}{H-F}$ assumes that the frictional heat is wholly expended in increasing the power of the steam; but the practical advantage of preventing the condensation in the cylinder assumes that this heat is nearly all expended in a manner which diminishes the power of the engine by increasing back pressure.

Professor Rankine explained that he did not intend to convey the impression that the heat generated by the friction produced actual mechanical work, but merely that it prevented a waste of heat.

Miscellanea.

The Knightbridge Professorship of Moral Theology, Casuistical Divinity, and Moral Philosophy in the University of Cambridge, now vacant, cannot be filled up until at least a fortnight after the beginning of term, October 1. The electors are the Vice-Chancellor, the Master of Peterhouse, the Regius Professors of Divinity, Greek, and Modern History, Lady Margaret's Professor of Divinity, and the Public Orator. The Professor will have to reside in the University for such a time, not exceeding eighteen weeks, in every year as the University may determine by grace of the Senate. The endowment is only 130*l.* a-year, but as almost all the other Professorships have been raised to 300*l.* a-year at least, it is probable that some provision will be made for adding to the stipend of this chair. Clergymen of the Church of England alone are eligible.

This letter has been addressed to the *Round Table*, for the benefit of the readers of *Blackwood*: "Heros von Borcke is not a myth or pseudonym, but the real name of a real man. I knew him in Paris several years ago—a large, awkward, green, *very* green youth he then was. Thompson may have made up the *Blackwood* papers from his notes or conversation; certainly Borcke could not have written them in their present form; he has not sufficient command of English.—C. A. Bristed."

At the meeting of the General Committee of the British Association on Wednesday, the 29th ult., Mr. Hirst submitted a financial statement, as follows:—

	£	s.	d.
Balance in hand	503	10	2
Estimated receipts of Nottingham Meeting	2,417	0	0
Subscriptions from old members	150	0	0
Sale of publications	250	0	0
Dividends on Stock	80	0	0
	£3,400	10	2
Expenses of Nottingham Meeting	300	0	0
Probable expense of printing report	800	0	0
Salaries	350	0	0
	£1,450	0	0

Mr. Hirst observed that the proposed grants amounted to 2,265*l.*, which would make the expenditure in excess of the receipts by about 300*l.* It was not probable, however, that all the grants would be applied for, and therefore it was calculated that the payments would be within the receipts. Resolutions from the Committee of Recommendations, involving the following grants, were then submitted to the meeting:—

	£	s.	d.
Kew Observatory.			
Maintaining the Establishment of Kew Observatory	600	0	0
Mathematics and Physics.			
Instruments for Observations in India	200	0	0
Lunar Committee	120	0	0
Electrical Standards	100	0	0
Reduction of Rumker's Observations (renewed)	150	0	0
British Rainfall	50	0	0
Balloon Experiments	50	0	0
Luminous Meteors	50	0	0
Meteorological Observations in Palestine	50	0	0
Sound under Water	30	0	0
Geology.			
Alum Bay Fossil Leaf Beds	25	0	0
Kent's Hole Investigation	100	0	0
Bournemouth Fossil Leaf Beds	30	0	0
Maltese Fossil Elephants	50	0	0
Fossil Crustacea	25	0	0
Kilkenny Coal Fields	25	0	0
Plant Beds of North Greenland	100	0	0
Secondary Reptiles	50	0	0
Biology.			
Insect Fauna, Palestine	30	0	0
Marine Fauna, Ireland	25	0	0
Dredging West Coast of Shetland	75	0	0
Physiological Action of the Ethyl and Methyl Series	25	0	0
Coast of North Greenland, Flora and Fauna	75	0	0
Geography and Ethnology.			
Palestine Exploration	50	0	0
Statistics and Economic Science.			
Metrical Committee	30	0	0
Mechanics.			
Analysis of Reports on Steamship Performance	100	0	0
Manufacture of Iron and Steel	25	0	0
Patent Laws	25	0	0
	£2,265	0	0

Prof. Wanklyn complained that no grant had been made in connexion with the Chemical Section, and asked Professor Miller whether there was any special rule applying to that section which did not affect the others. A motion was made for a grant for some chemical experiments, but he understood it had fallen through in consequence of some informality. Professor Miller said the application referred to by Prof. Wanklyn would go more properly before another source of supply. So long as he had been connected with the association, it had been the practice not to entertain applications for grants with a view to making experiments, unless committees were appointed to superintend the experiments. In the fund placed by the Government in the hands of the Royal Society, there was provision for furthering individual inventions, and it did not appear to the General Committee that the matter Professor Wanklyn had spoken of came within their scope. Sir Samuel Baker, and W. F. Webb, Esq., were added to the vice-presidents of the Association, and Professor Ramsay was appointed a member of the Council.

Messrs. Blackwood and Co. have in the press: "The History of Scotland from Agricola's Invasion to the Revolution of 1688," by John Hill Burton;—"Memoirs of the Confederate War for Independence," by Heros Von Borcke, Chief of Staff to General J. E. B. Stuart, in 2 Vols., with a Map;—"Lectures on the Early Greek Philosophy and other Philosophical Remains of the late J. F. Ferrier, LL.D.," Edited by Sir Alexander Grant, Bart., and E. L. Lushington;—"Miss Marjoribanks," by the Author of "Salem Chapel," a Cheap Edition;—"Discussions on Philosophy and Literature, Education and University Reform," by Sir William Hamilton, Bart., a New Edition;—The Third and Fourth Volumes of "The Monks of the West," from St. Benedict to St. Bernard, by the Count De Montalembert, Authorized Translation;—"Physiology at the Farm in Rearing and Feeding the Live Stock," by William Seller, M.D., and Henry Stephens;—"A Handy Book of Horse Law, and of the Laws relating to English Sports," by C. G. Merewether, Esq., of the Norfolk Circuit;—"A Handy Book of Meteorology," by Alexander Buchan, Secretary of the Scottish Meteorological Society.

Mr. Bentley announces "For Ever and Ever," a New Novel, by Florence Marryat (daughter of the late Captain Marryat, R.N.).

The "General Report on Public Instruction in the Lower Provinces of the Bengal Presidency for 1864-65" has just been transmitted to us from Calcutta. It is a bulky volume of 500 pages with numerous tables of statistics. During the year there has been an increase of 583 schools, and 22,792 scholars. The total average cost per head of each scholar was Rs. 19 11 10, of which Rs. 12 2 10 was paid by the State. Of the 1,281 candidates from Bengal for the entrance examination of the University of Calcutta 33 were Mohammedans, 55 Christians, 1 Parsee, and 1,192 Hindus. These last were divided again into 64 Deists, 68 Brahmists, 1 inquirer after religion, and 1 following natural religion.

Mr. David Forbes, in the *Geological Magazine* for September, has a short but interesting paper on the geological periods at which gold has made its appearance in the crust of our globe. He designates the two epochs of auriferous impregnation as—1, The older or auriferous granite outburst; 2, The younger or auriferous diorite outburst. The first occurred some time between the Silurian and Carboniferous periods. The gold formations belonging to this period present themselves in Australia, Bohemia, Bolivia, Brazil, Buenos Ayres, Chile, Cornwall, Ecuador, Hungary, Mexico, New Granada, Norway, Peru, Sweden, Ural, Wicklow; and also such deposits of gold as are found intruded as quartz nodules and veins, as if interstratified in the Cambrian and Silurian systems, which he believes to have been rendered auriferous solely from their proximity to invisible or now superficial granites. The newer outburst cut through strata containing fossils of decided Post-oolitic forms, and possibly may be as late as early Cretaceous. If Mr. Forbes is correct with respect to this comparatively recent creation, so to speak, of gold, we may hope that, whatever is the case with coal, the supply of gold may possibly be inexhaustible; as there seems no reason why fresh "outbursts" of the igneous Diorite should not recur at any period, and either produce gold with their Midas-like touch, or like a Plutonic visitor of Danae, send their auriferous veins upwards for the corruption of Man.

A new system of education is about to be tried on a somewhat extended scale. All our readers may not have heard of the International Education Society. It is a society formed to establish International Colleges or schools, the chief aim of which will be to impart a thorough acquaintance with the modern languages, and the principles of natural science, without detriment to the regular course of studies. The society mainly owes its existence to the late Mr. Cobden, who was its founder and first president, and among the directors at the present time are some of our most eminent men in literature and science. A London College has been established by the society, and will be opened with a full staff of masters on the 18th of this month. The success of the school is probably ensured from the fact that the late Rector of the High School of Edinburgh, Dr. Schmitz, is the head master.

Another important feature in the school is that no sectarian religious instruction will be given, except such as is expressly desired by the parents or guardians of the pupils. Corporal punishment and fagging will not be tolerated, and a high tone of morality and honour sought to be maintained. A healthy and pretty spot has been chosen at Spring Grove, about ten miles from Waterloo Station. The grounds of the College extend to eight acres, on which a large permanent building is in course of erection, and meanwhile a commodious residence in the vicinity is occupied. Heartily we congratulate the society upon having secured so many advantages in their London College. With such a Principal, this new undertaking ought to be a great success. After a firm foundation has been laid in England, the society intends to open other schools on the Continent, where the same method of instruction will be employed. To these foreign Colleges pupils can, if desired, be transferred, continuing their regular study, whilst receiving instruction through the medium of another language, the advantages of which will be obvious. Thus it is fairly hoped that, on completing the curriculum of the College, the pupils, besides having received a liberal education, will have been taught to write and speak two or three modern languages in addition to their own, and will have gone through an extensive course of instruction in the natural sciences. This school is evidently beyond the middle classes, who indeed at present receive more scientific instruction, such as it is, than do those in the higher class schools. But why should the middle classes be precluded from obtaining for their children a certain amount of sound instruction in science? Which is better, for a tradesman's son to know what is the meaning of the Æneid, or the meaning of an electric current? As for the training to the mind given by classical studies, it will be equalled by the training afforded by a well-taught course of scientific instruction. A middle-class public school, richly endowed, is about to be opened in London. In some of its features its system resembles the International College. We trust its managers will do still more, and shortly introduce the teaching of science in every class in the school. More than this, is it too much to expect that the flippant nonsense taught at so many ladies' schools will soon be superseded by thorough instruction in French, German, and elementary science? Then, indeed, will the methods and results of scientific thought and inquiry, the influence of which in every direction has been so steadily progressing, have accomplished one of their greatest triumphs, for they will have obtained a grip of the public mind, which, once aroused, will utterly banish those errors and prejudices which mar our present system of education.

An attempt is being made to resuscitate the operations of the Oriental Translation Committee. The Oriental Translation Fund was established in 1828 by several Oriental scholars and others interested in Eastern literature, "for the translation and publication of such works on Eastern history, science, and *belles lettres* as are inaccessible to the European public in MS. form and indigenous language." This scheme received at first very considerable support, and the reigning Sovereign has from its commencement always been the Patron of the undertaking. During a period of thirty-two years the Committee have published, or aided in the publication of more than seventy translations. Of these many are highly valuable, all are curious and interesting, and several of them are of such a nature, that without the aid afforded by the Society, they could scarcely have been undertaken. The Sanskrit translations include those of the Sankhya Karika, Rig Veda, and Vishnu Purana. Amongst those from the Arabic, are found the travels of Ibn Batuta, and of the Patriarch Macarius, Al-Makkari's history of the Muhammadan Dynasties in Spain, and the extensive Lexicon of Hajji Khalfa. There are also on the list translations from the Persian, Syriac, Ethiopic, Armenian, Chinese, and Japanese languages. For the last two or three years no work has been issued from the press of the Society, nor is any one preparing for publication; but as there are signs in the literary world of a renewed interest in Oriental learning, the Committee invite the special co-operation of all those who are anxious to bring the East and West into a still closer communion with each other. We trust attention will be particularly directed to Chinese encyclopædias, which contain a mass of knowledge whose value is known but to few.

The *Edinburgh Courant* says that a meeting of the Town Council of Dundee was held on Wednesday last, when it was resolved to authorize the working committee appointed to make preparations for the meeting of the British Association in Dundee in 1867, in terms of their request, to issue circulars to the Commissioners of Supply of the Counties of Fife, Forfar, and Perth, the Royal burghs of these counties, the Scotch Universities, the corporate bodies in Dundee, and the various other public bodies in the three counties, inviting them to co-operate with the town of Dundee, in order to render the meeting of the Association a successful one; and to appoint committees of their number to join the working committee, so that a general committee might be afterwards chosen and subscriptions raised. The provost, magistrates, and councillors were appointed members of the committee.

The usual Great Autumn Choral Festival of 5,000 voices, conducted by Mr. G. W. Martin, will be held at the Crystal Palace on Saturday, the 15th. The programme will consist of two parts—sacred and secular. Some of the pieces are arranged for four treble voices, and will be given by a thousand voices to a part. Every exertion is being made to make the day one of unusual attraction. This will be the only shilling Saturday in the year.

A new weekly Catholic journal for the working classes, called the *Universal Express*, is to commence this day. The second number will include a portrait of Dr. M'Hale, Archbishop of Tuam, and Cardinal Cullen, Archbishop Manning, Dr. Newman, and others will follow.

An American paper states that a party of five young men, while on an exploring expedition recently along the Colorado River, discovered an immense pyramid on a barren plain. It was composed of layers of stone from 18 inches to nearly 3 feet in thickness, and from 5 feet to 8 feet in length. It had originally a level top of more than 50 feet square, though it was evident that it had been completed and that some great convulsion of nature had displaced its entire top, as it was lying on one of its sides, a huge and broken mass, nearly covered by the sand. Its present length is 104 feet, and it must have been formerly full 20 feet higher. This pyramid differs in some respects from the Egyptian pyramids. It is, or was, more slender or pointed, and while those of Egypt, says the *Times*, are composed of steps or layers, receding as they rise, this American pyramid was undoubtedly a more finished structure. The outer surface of the blocks was evidently cut to an angle that gave the structure, when new and complete, a smooth or regular surface from top to botton. The *Times* is mistaken in supposing the Egyptian pyramids never had a smooth surface. The cement with which they were originally covered, has disappeared in the course of ages, but at one time the steps, which were merely left for the convenience of erection, were completely covered.

The fourth field meeting of the Berwickshire Naturalists' Club was held on the 30th ult., at Cockburnspath. The ruined church of St. Helen, standing in a lonely situation near the sea, was examined with attention. A popular legend invests it with interest, for tradition says it was one of three churches erected in Saxon times by three sisters.

St. Abb, St. Helen, and St. Bey.
They a' built kirks whilk to be nearest to the sea;
St. Abb's upon the nabbs,
St. Helen's on the lea,
St. Bey's upon Dunbar Sands
Stands nearest to the sea.

Of this Saxon church there are, however, now no remains; but the chancel with its covered stone roof, and the side walls of the nave, are of the Norman style of architecture; and several stones with the chevron ornament, derived from this Norman structure, have been built into the western gable at a subsequent period. At a short distance westward are traces of an ancient British habitation, within which have been found bones, several of the *Littorina littoralis*, and vitrified rock, indicating probably the remains of an ancient feast. The geology is, however, the most important feature of the district, and there are evidences of an upheaval of the land in a comparatively recent period; for on the borders of the county, not far from Dunglass Dene, there is a raised beach, the base of which is twelve feet above high-water mark. The late Rev. Andrew Reed, one of the original members of the club, found here shells of species now living, and the bone of an ox, of a variety much smaller than is now seen in the Lowlands of Scotland. After the researches of the day were over, the parties reassembled and dined at the hostelry of Cockburnspath, Mr. Tate, of Alnwick, who had acted as guide to the party, occupying the chair, and Mr. Stevenson acting as croupier. Afterwards reports were made by Mr. Middlemas of the ferns noticed in Pees Dene; by Mr. Langlands of St. Helen's Church and the Ancient British settlement; and by Mr. Tate and Mr. Stevenson on the geology of the district.

The concentration of the luminous rays of light at the focus of the telescope when the sun is the object to be observed, renders observations very difficult and sometimes even dangerous. M. Leon Foucault has conceived the idea of utilizing the property which certain metals possess of arresting the calorific rays, whilst they allow the luminous rays to pass through. Silver, when deposited by a particular chemical process in very thin layers, possesses this property in a very high degree. M. Foucault has sheathed the objective of a telescope with a layer of this metal, and there is produced at the focus of the instrument an image perfectly clear and agreeable to the eye. It exactly resembles one which a violet-coloured glass would produce.

Besides the rare bones of the Glyptodon, Megatherium, and others to be sold by Mr. Stevens, on Tuesday, one lot consists of a restored model of the *Glyptodon clavipes*, and another of a similar model of the *Schistopleurum* of L. Nodot. Perhaps the most interesting lot of all is No. 156, consisting of the pelvis, right and left femur, and right and left tibia of the extinct Dodo, from Mauritius.

Two thousand men are now employed on the building and grounds of the Alexandra Park and Palace. The park is laid out by Mr. McKenzie.

The *Round Table*, in an article headed "Miss Braddon and International Copyright," lays whatever blame might otherwise have attached to its conductors in the matter of "What is this Mystery?" and the remarks that journal made upon it, upon Mr. Hilton and "our blundering, short-sighted legislators;" and concludes with these remarks upon a subject of great importance to the authors and publishers both of England and America: "Literary piracy is of course much more shocking to people who are fortunate enough to live in a community where literary property is respected; and our publishers are so much in the habit of filching English books—and our public in that of profiting by it—that even when the offence is aggravated by a direct misrepresentation—rebaptising a work and professing to have received the author's advance sheets—it is more than doubtful whether the exposure will have any considerable restraining influence in the future. Broadly speaking, traders will not pause to draw delicate distinctions at the point where morality and legality diverge; they will take the path which promises most profit. The fault lies in our Legislature, which cares little for our own authors, because they are few and therefore weak, and nothing for foreign ones, because they cannot help themselves. If the majority which puts them in power wrote books, we should not want long for an international copyright law. As it is, civilization moves on in Europe and stands still here. England and France, with different tongues, have established reciprocal literary protection; America and England, with a common one, refuse it. The pains and consideration which the late Congress devoted to increasing its own pay would have remedied the evil, for there would not be the least hesitation on the other side. The hours it expended upon topics of personal vituperation and blackguardism would have sufficed to settle the question twice over. But there would have been fewer dollars to pocket, as well as fewer hard names; and to get dollars and to call hard names are enjoyments which, for the present, American legislators cannot be expected to forego. We by no means, however, despair of the republic of letters. We intend to omit no pains, to leave no stone unturned, to get this stigma removed, this blot effaced from the national escutcheon. Both in our columns and out of them, we propose, during the approaching session, to labour for this end. Other presses may, as is their wont, let the subject drop into desuetude, because they see no immediate gain to be derived from its discussion; but the public, both home and transatlantic, may rest assured that such will not be the case with the *Round Table*."

The same journal says of some passages in Mr. Swinburne's late volume: "This is sad, dreary if you will, but not more so than the *Book of Ecclesiastes*, which still holds its place in the inspired writings."

THE READER.

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